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AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

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Vol. 31. No. 15.

Index to Advertisers and Classified Index Following Reading Matter.

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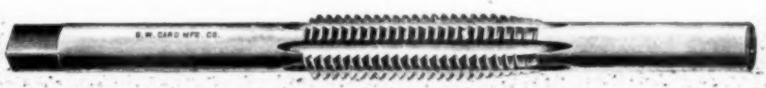

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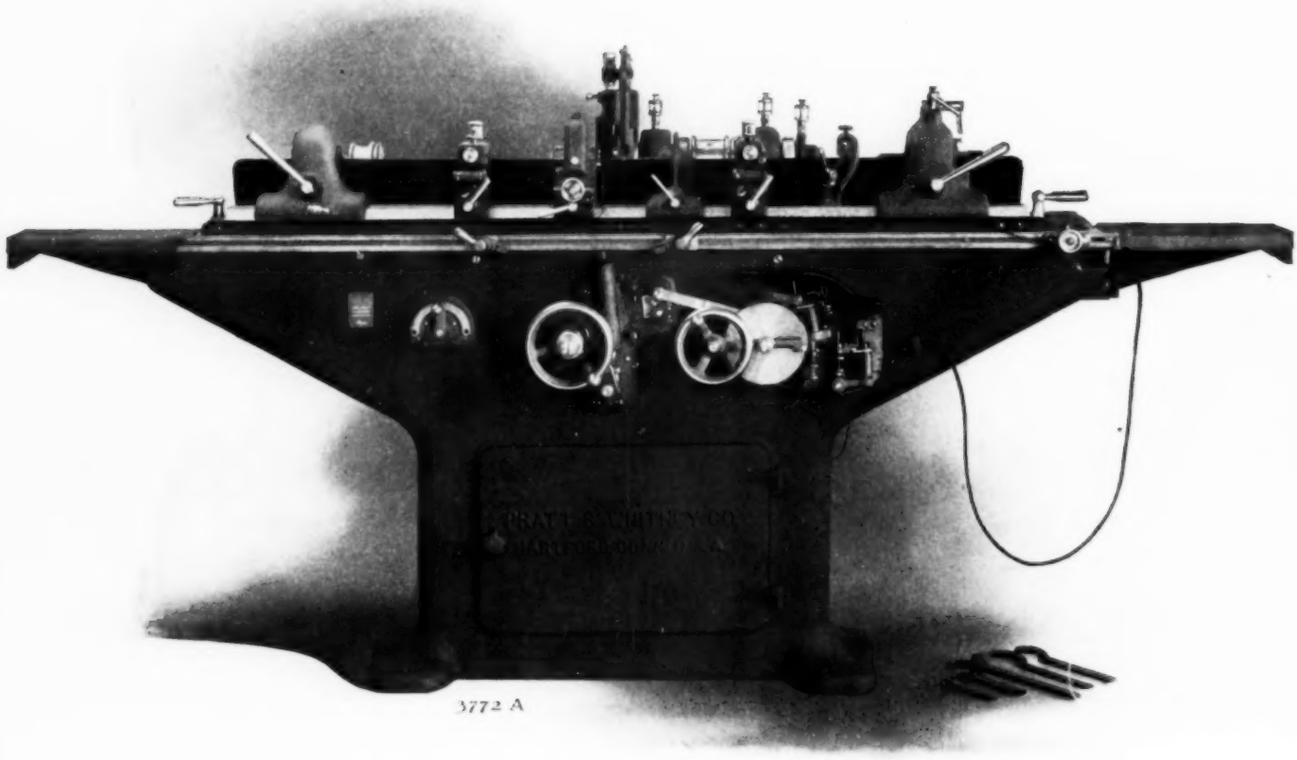

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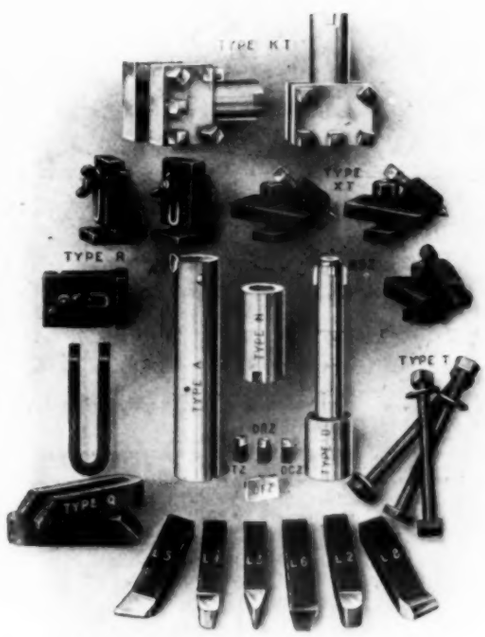

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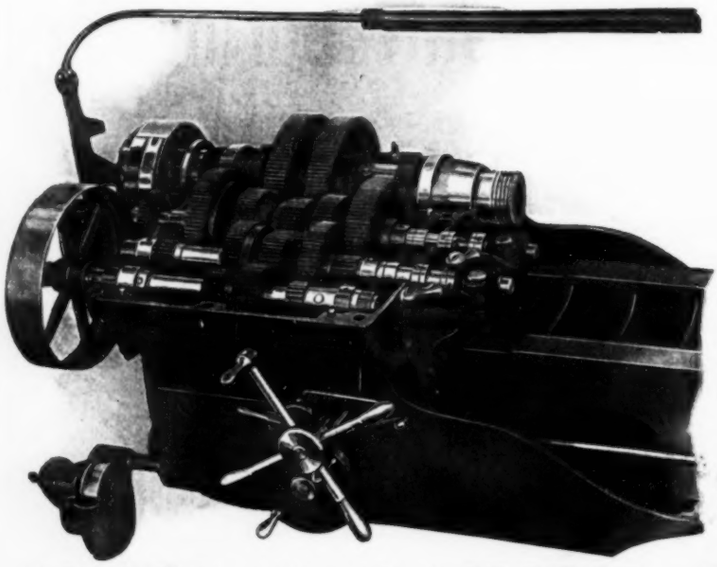

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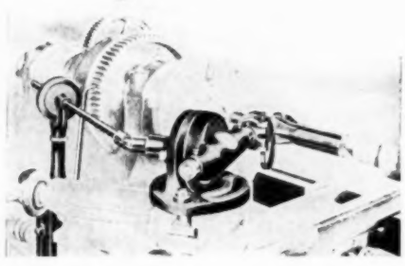

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Electromagnetic Hardness Tester

Its Design, Operation and Principle. How to Judge Carbon Content and Strengths of Steel by Its Hardness. Work and Results Obtained

BY E. F. LAKE

The necessity of knowing the properties of metals before using them has caused the invention of many different kinds of machines that will give accurate results when making tests.

As it is often desirable to know the exact degree of hardness of a piece of steel the principle of the magnetic balance has been brought into use and an instrument designed like that shown in Fig. 1 has given good results for certain classes of work.

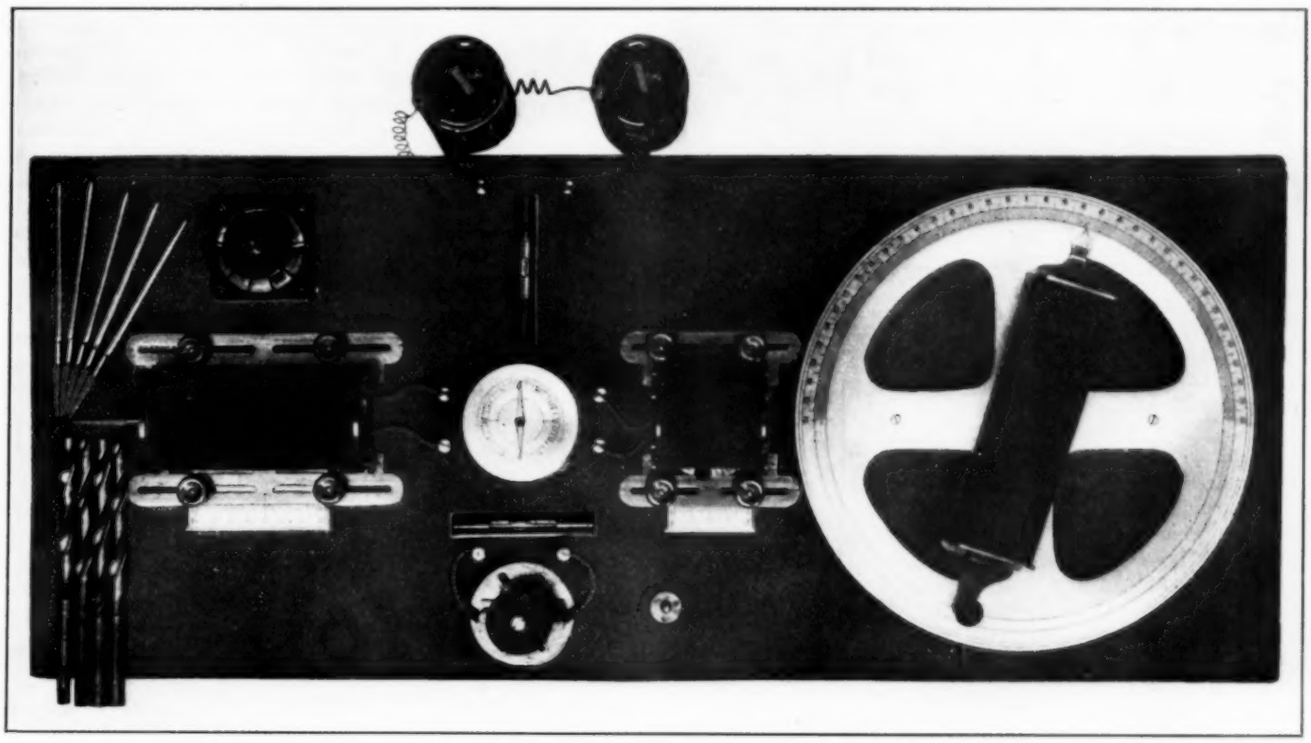


FIG. 1. ELECTROMAGNET INSTRUMENT FOR TESTING HARDNESS

Ferro-magnetic bodies are governed by the following two laws:

First—The magnetic capacity is directly proportional to the softness or molecular freedom.

Second—The resistance to a feeble external magnetic force is directly as the hardness or molecular rigidity.

These laws hold good for every variety of iron and steel and the magnetic balance shows that annealing not only produces softness in iron, and consequently molecular freedom, but it entirely frees it from all strains previously introduced by drawing or hammering.

Thus a bar of steel drawn and hammered may have a fibrous structure, and this would give a greater mechanical strength in one direction than in another, but if thoroughly annealed after heating to its highest recalescent point even traces of its former strains are removed and it becomes homogeneous in all directions by the molecular cohesive force equalizing itself in all directions from the common center. If, however, any distinct separations of the molecules have taken place, they will show in the form of microscopic crack, or in cracks large enough to be seen with the naked eye, and these will retard the equalization of the cohesive force.

Hardness and Carbon Content

The carbon contents of all steels are relatively proportional to their hardness, whether the metal be annealed, hardened, or tempered; therefore, by using a hardness-testing instrument that will give accurately the degree of hardness, the carbon contents of the metal can be judged.

In calculating the carbon contents by this method different standards will have to be used for different grades of steel as some of the materials used in the ordinary and alloyed steels alter the degree of hardness given the metal by the carbon, but if a set of standards are established for the different grades of steel, then the percentage of carbon can be ascertained. Practical tests have shown that the carbon contents can be estimated within about 0.025 per cent.

Hardness is only a relative term, yet to the practical mechanic working in steel it has a definite meaning, and it is one of the principal properties of this metal. If a set of standards have been established the degree of hardness will also indicate the tensile strength and other properties which a given grade of steel should have.

As the best grades of steel may fail if they are not properly heat-treated it is not only necessary to know the chemical composition and the physical properties of the metal, but also that the right degree of hardness has been obtained, as the highest efficiency of a given piece of steel is in all cases at a certain degree of hardness, whether that efficiency refers to strength, elasticity, cutting or any other qualities.

Thus accurately obtaining the degree of hardness is very important for many classes of work and the instrument described in this article will give these results on all paramagnetic metals which have not been previously magnetized. Metals which have been magnetized by numerous tests in this instrument or by some other means, will not give the read-

ings which they should owing to the greater resistance given the magnetic current sent through them by the instrument.

Tests can be made on pieces in the rough as well as finished work regardless of their shape. This makes a rail or projectile as easy to test as a finished razor blade and materials can be tested before any work has been done on them as well as getting the degree of accuracy with which the finished work has been heat-treated.

Table No. 1 gives the magnetic capacity of cast iron and steel with different percentages of carbon from readings on the instrument. It also shows the tensile strength which these metals should have.

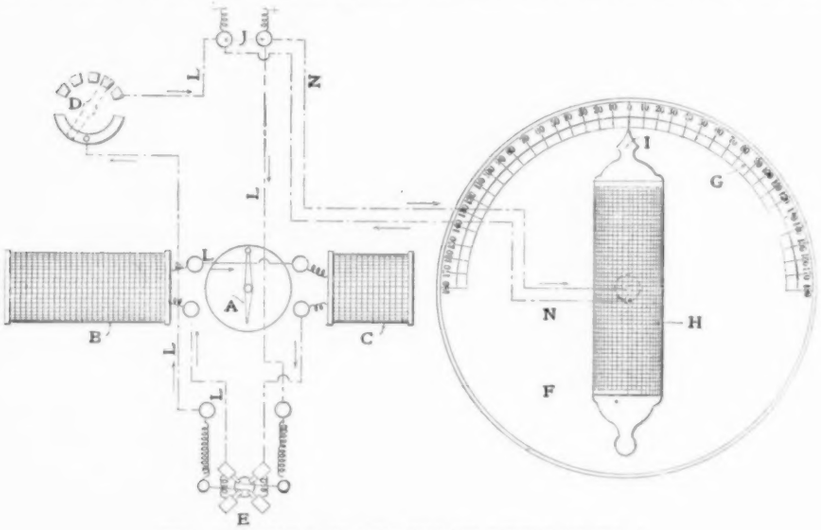


FIG. 2. DETAILS OF INSTRUMENT SHOWN IN FIG. 1

The Instrument in Detail

On preparing the instrument for use the plate on which the apparatus is mounted must be perfectly horizontal. In order to obtain this position two spirit levels are affixed to the plate on either side of the magnetic needle as shown in Fig. 1, and four adjusting screws are used for feet on the underside of the plate. Two of these are shown in Fig. 3 and turning them to the right or left raises or lowers the plate.

The instrument must then be located so the magnetic needle *A*, Fig. 2, will point north and south when at the two zero points on the copper dial underneath it. The needle and dial are covered with a case with a glass top so as to eliminate the effects of the pressure and currents of the air. Oscillations of the needle are stopped by pressing on a push button which lowers the pivot until the needle strikes the dial.

Solenoids or spools *B* and *C* are mounted on the plate by being fastened to a metal frame with four slots in it, as shown in Fig. 1. They are held in position on opposite sides of the magnetic needle by bolts which pass through the plate and the slots in the frame. On these bolts are nurled nuts and the solenoids can easily be moved close to or away from the magnetic needle in order to increase or reduce the magnetic force. Beside each solenoid is located a scale so that a fine adjustment and accuracy can be obtained in the increase or reduction of the magnetic force.

A rheostat *D* is located back of solenoid *B* for regulating the current and in front of the magnetic needle *A* is a commutator *E*. This is used to reverse the current of electricity passing through the solenoids.

To the right of the small solenoid *C* is a compensator *F*. This consists of a large copper disk, each quarter of the half of which is divided into 180 equal parts as shown at *G*. On top of this disk is mounted the electro magnet *H* which is provided with the indicator *I* for giving the readings on the circular scale.

Two or three dry batteries may be used to furnish the current and these simplify the operation, but others can be used, providing the current furnished is sufficiently constant. The batteries are connected to binding posts *J* on the plate and should provide a current of from 3 to 8 volts. A galvanometer may also be attached to the instrument for determining the force of the current.

Operating the Instrument

One current passes from the battery through the commutator *E*, the testing solenoid *B* and the small solenoid *C*, thence through the commutator *E*, the rheostat *D* and back to the battery. Its direction is shown by the dotted line *L*. This current can be made to flow in the opposite direction by reversing the commutator.

Another current passes from the battery through the electromagnet *H* and back to the battery. The direction of this is shown by the dotted line *N*. With these two currents the magnetic balance is obtained.

Before putting the piece to be tested in the instrument the indicator *I* on the electromagnet should be placed at zero, the current sent through the solenoids in one direction and the solenoids moved toward or away from the magnetic needle *A* until it rests at the zero point. The current should then be reversed by the commutator to see that the magnetic needle did not move away from the zero point. This would prove that the instrument was in true balance.

The current through the solenoids should be turned off and the piece to be tested inserted in the center of solenoid *B*

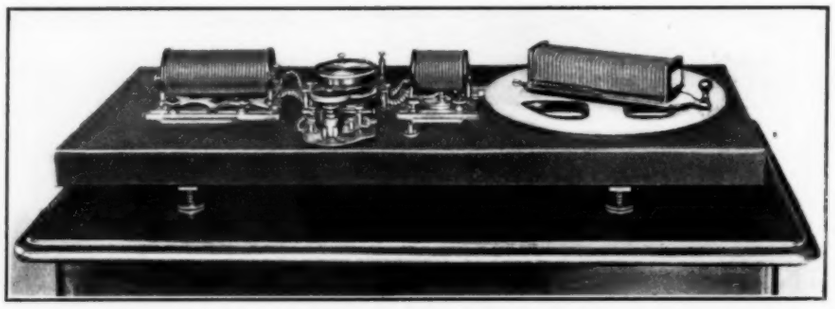


FIG. 3. THE INSTRUMENT ON TABLE READY TO USE

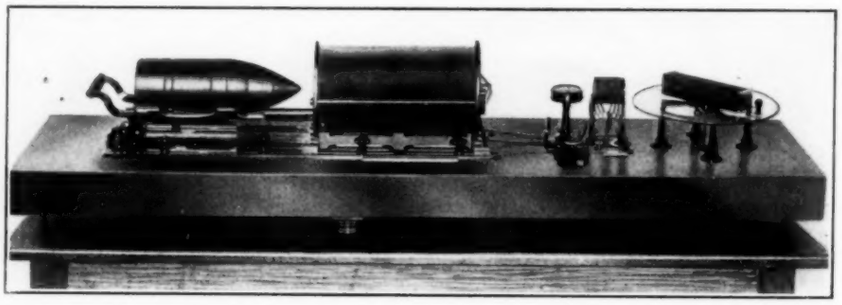


FIG. 4. INSTRUMENT FITTED WITH SLIDING CARRIAGE

which should be provided with supports for holding the same. Its position is shown by the end of the reamer which projects from the solenoid in Fig. 1. The current should then be turned on and this will cause the magnetic needle to move to the east or west, owing to the test piece becoming magnetized and disturbing the balance of the instrument.

The electromagnet H is then moved to the east or west enough to bring the magnetic needle back to the zero point and establish a magnetic equilibrium. The figure which the indicator I, on the electromagnet H, points to, on the scale G, is recorded as the first reading. The current through the solenoids is then made to flow in the opposite direction. This causes the magnetic needle to deflect in the opposite direction from the zero point and the electromagnet is moved in the opposite direction to bring the magnetic needle back to zero. The figure to which the indicator I then points is added to the one previously obtained on the opposite side and the total is called the magnetic capacity of the test piece.

To determine the magnetic capacity by passing the current direct or reverse through a piece it must not have any of the artificial magnetism given it by forging or tempering, forged or tempered iron or steel always being magnetized.

Cubic Content

In comparing the hardness of pieces of different sizes and shapes on this instrument it is necessary to know the cubic contents of each piece, as by placing a test piece in solenoid B we obtain an electromagnet which must be balanced by the electromagnet H and the greater the cubic contents the greater will be the magnetic force required to effect this balance.

After placing a piece of iron or steel in the testing solenoid we have an electromagnet of which the magnetic body (m—1) flows through the magnetic body (m—2) from the needle of the compass, in such a way that the force (f), with which a magnetic pole attracts or repulses the opposite pole, is proportional to the size of the active bodies m—1 and m—2 and is in reverse proportion to the square of the distance (r) between the magnetic poles.

Thus

$$f = \frac{m-1 \quad m\,2}{r-2}.$$

Using this formula the solenoids can be placed in accord with the needle of the compass by moving the objective solenoid toward or away from the needle and moving the right-hand solenoid until the proper balance is obtained. This will strengthen or weaken the electromagnet according to the size of the piece being tested.

Kind of Metal.	Percentage of Carbon.	Magnetic Capacity.		Tensile Strength in Pounds per Square Inch.
		Annealed.	Hardened in Oil.	
Cast Iron.....	0.07 to 0.10	450 to 400	420 to 380	
Carbon Steel.....	0.10 to 0.20	380 to 300	250 to 200	51,500 to 67,000
Carbon Steel.....	0.20 to 0.30	300 to 270	200 to 180	67,000 to 83,000
Carbon Steel.....	0.30 to 0.40	270 to 250	180 to 160	83,000 to 98,500
Carbon Steel.....	0.40 to 0.50	250 to 230	160 to 130	98,500 to 114,000
Carbon Steel.....	0.50 to 0.60	230 to 200	130 to 120	106,500 to 114,500
Tool Steel.....	0.80 to 1.30	200 to 170	110 to 80	

TABLE 1. MAGNETIC CAPACITY OF METALS WITH VARIOUS CARBON CONTENTS

Shape of Piece.	Diameter or Cross-section Size.	Square Inches of Surface.	Weight, in Grams.	Cross-section, in Square Inches.	Actual Magnetic Capacity.		Magnetic Capacity in Proportion to 100 Grams.		Magnetic Capacity in Proportion to 10 Square Inches.		Magnetic Capacity in Proportion to Cross-section of 1 Square Inch.	
					Annealed.	Hardened in Oil.	Annealed.	Hardened in Oil.	Annealed.	Hardened in Oil.	Annealed.	Hardened in Oil.
Square.....	0.312	8.07	79.06	0.097	190	110	240	139	231	136	195	113
Round.....	0.312	6.34	61.98	0.076	170	82	274	132	267	130	222	107
Rectangular.....	0.312 by 0.208	6.69	52.62	0.065	155	82	294	155	235	123	239	126
Rectangular.....	0.312 by 0.156	6.00	39.61	0.049	140	58	353	146	233	97	287	119
Square	0.208	5.34	35.10	0.043	130	53	370	151	243	100	300	122
Round.....	0.208	4.19	28.48	0 034	110	46	386	161	262	109	323	135
Square	0.156	3.99	19.75	0.024	95	36	481	181	238	89	395	150
Round.....	0.156	3.13	15.87	0.019	80	29	504	182	255	92	418	151
Results of various test pieces.....					110	81	264	50	36	47	223	44

TABLE. 2. HARDNESS TEST OF PIECES OF DIFFERENT SIZES AND SHAPES.

Special tests were made with pieces of different sizes and shapes of a steel of the following composition: Carbon 0.40 per cent., manganese 1.03, silicon 0.07, sulphur 0.04, and phosphorus 0.06, and the results are shown in Table 2.

In this table it will be seen that the magnetic capacity is proportional to the surface of the piece and its body.

Application

By extensive experiments it has been shown that the electromagnetic instrument agreed with the physical tests for testing hardness. Among the physical tests used in comparison was the Brinall test. A test, however, which is made by pressing steel balls into a test bar, or with a knife edge pressed in, or with punches or files can only be approximately correct and cannot be used at all when the metal tested is in its hardest state, therefore a magnetic balance is far superior to these methods.

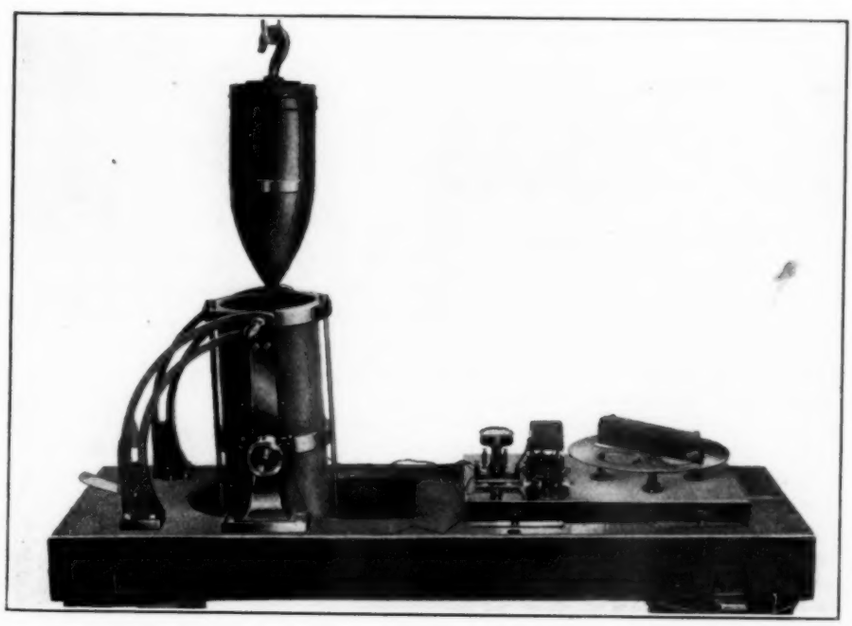


FIG. 5. INSTRUMENT FITTED WITH TILTING SOLENOID

The instrument has been used successfully in Europe for testing the lock on gun barrels and these gun locks were tested in comparison with a bar of iron thoroughly annealed, which gave a magnetic capacity of 220. In 8 hours as many as 1000 pieces have been tested.

Before using the instrument a great many pieces broke and split, but with the instrument degrees of temperature for hardening and tempering the metal were established which nearly abolished these faults.

In the testing of projectiles this instrument has also been made very useful in Europe, and Fig. 4 shows an instrument fitted with a sliding carriage for inserting the shell into the solenoid. This style of instrument will handle projectiles up to 6 inches in diameter. Fig. 5 shows the same instrument fitted with a tilting solenoid so that large projectiles can be easily handled by lowering them into it and then bringing the solenoid into a horizontal position.

The main points of usefulness lie in the facts that the instrument can test finished work without marring or indenting the finished surfaces; that it can be used on rough metal, such as castings, as well as on finished work; that it gives positive readings or figures by which the hardest steels can be compared with others, as well as the softer steels and that it can be operated without any special knowledge or skill. It will not, however, test non-ferrous metals and is therefore limited to iron and steel.

The instrument is the invention of Prof. D. E. Hughes and is sold in this country by Schuchardt & Schütte, 136 Liberty street, New York.

Some Grinding Machine Troubles and What Causes Them

By Jas. N. Heald*

We would like to hear from your readers in regard to the amount of money and time a manufacturer should be called upon to spend with a customer in getting his machine running in a proper manner, and to prove that it will fulfil the representations made in regard to its ability to handle the work for which it was sold.

Our company is manufacturing a line of grinding machinery which is rather special in its character, and it seems as though the purchasers of the machines succeeded in making every conceivable error possible in regard to setting up and operating them.

It has seemed incredible in going about from shop to shop that so many errors should be made by mechanics who apparently should be able to understand the machines put into their charge, and it has reached a point where we have decided to ship out no more of these machines without sending a competent man to start the machine up and instruct not only the operator in regard to the handling of it, but to a certain extent the foreman and often the superintendent in regard to the ordinary fundamental principles in the use of grinding wheels.

As a first illustration we would cite a case which occurred a few days ago when we received a telegram asking us to "send expert at once, machines working badly." These were machines that the people had had something like a year and a half or two years, and so far as we knew were giving satisfactory results. We wired them for information in regard to the character of their difficulty, as this concern is located something like 800 miles away, and the only information their letter

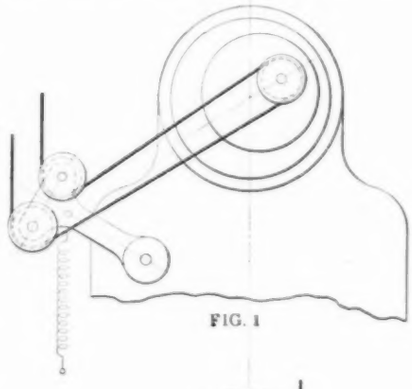


FIG. 1

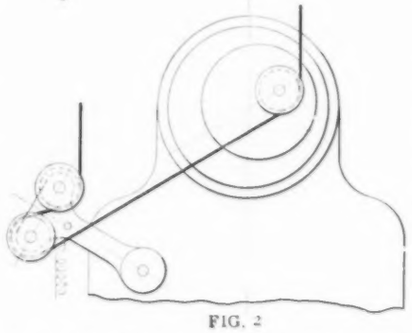


FIG. 2

RIGHT AND WRONG WAY OF BELTING GRINDER

in answer gave was that the machine was grinding the holes 0.002 inch and 0.003 inch larger at one end than the other.

Improper Wheel Speeds

On the arrival of our expert he found they were not handling the machines to very good advantage in several ways, but the principal trouble was due to the speed at which they were running the grinding wheels. The instructions we send with the machine are to run the countershaft at 700 turns per minute, giving from 6300 to 6400 turns per minute to the grinding wheel. Thus, with a wheel 3½ inches diameter, the size when new, gives a circumferential speed of about 5700 feet per minute and when worn down to 3 inches or less in diameter, gives a speed of 5000 feet per minute. This, of course, is according to the average recommendation of grinding-wheel makers, who usually print tables in their catalogs showing the speed that different sizes of wheels should run to give 4000, 5000 or 6000 feet per minute, 5000 being the usual speed, but this being modified according to the character of the work and the shape and strength of the particular form of grinding wheel used.

On putting the speed indicator on the machine, it turned out that they were running this grinding wheel at 3800 turns. Now, 3800 turns for a 3½-inch wheel gives 3480 feet per minute and 3800 turns for a 3-inch wheel gives only 2990 feet per minute, not much more than one-half the speed recommended by us for these wheels.

It would seem as though a man who was competent to have charge of other workmen, either as foreman or superintendent, ought to know better than to run a grinding wheel of this size at this low speed.

The slow speed of the countershaft made the entire machine run slow so that the output was greatly decreased, due both to the poorer cutting qualities of the wheel and also to the fact that every feed and speed was slow on the machine.

Now, the question is, is it reasonable for a manufacturer to be asked to send a man 700 or 800 miles simply to speed up a grinding wheel so that it shall be able to cut in a reasonable and satisfactory manner?

Another feature in this case is that only a short while previously these same people had complained in regard to the grinding wheels that we sent them, reporting that they did not cut well and did not appear to be very good wheels for their work.

In our own works we have one of these machines in operation, it being used partly in grinding sample cylinder castings for customers so that we may select for them the best wheel for any particular grade of iron which they may be using, from our stock of different grades and grits, and it is very easy to see that our selection may be considered to be a very poor one if the conditions vary so between the machine we try out the wheels on and the machine on which they are used.

Wheels Should be True

Another case along this same line is one where we shipped a machine over 1000 miles and shortly afterward received a telegram worded as follows: "Cannot get smooth work, machine radically wrong."

On receipt of this telegram we decided to hazard a guess that their trouble was due to not truing up the wheel.

It is surprising to see how few people realize that a grinding wheel in order to do nice work must have its cutting face absolutely true. We, therefore, wired back, "Have you trued the wheel off with a diamond?" and wrote them explaining

*General manager, Heald Machine Company.

the importance of using a mounted diamond set in the holder which we furnish with every machine to produce a true surface on the wheel.

A few days later we received a letter saying that they had done as we suggested and were having no further trouble. In the meantime they had sent us a ring, the edges of which had been ground on this machine and this ring showed a series of hollows about ⅛ inch apart which was the exact amount the work advanced for every revolution of the grinding wheel. The whole trouble was that they had put the grinding wheel on the wheel arbor, tightened up the nut and started in to grind without taking any notice whatsoever as to whether the wheel ran true or not when put to work.

While the manufacturers of emery wheels undoubtedly plan to have the hole in the center of the wheel as nearly as convenient, it is not anywhere near enough in the average case even if the bushing is a good fit on the spindle to give smooth work, and it is absolutely necessary, if one is going to get results that are satisfactory, to true off the wheel after it is fastened so that every point of the wheel will cut equally and smoothly.

For some reason or other it seems as though people who buy a lathe, planer or drill, assume that if they do not get good work their operator is at fault, but when they buy a grinding machine they seem to assume in every case that if they do not get the results desired the trouble is all with the machine. Why this distinction or difference in looking at things has grown up we would be interested to know, but it is certainly a fact, as makers of the leading types of plain and universal grinders will surely testify.

Troubles Due to Wrong Method of Belting

In another shop the machine was found belted up to run backward, in spite of blueprints sent along with the machine, boxed in the same box with the fittings and grinding wheels, and showing the method of belting up and with arrows indicating the direction in which the belts should run.

One of these machines was a thousand miles from the factory and another was perhaps 400 miles away. In the shop first referred to, where the machine was running the wrong way, they had seen fit to belt the machine up a little differently from what we had intended.

In Fig. 1 we show the method we designed to use in which pulley *A* is driven by a belt coming forward from under two idler pulleys and making an excellent and powerful drive for the grinding wheel. Our customer, however, either failed to find the blueprint or for some reason or other saw fit to belt it up according to Fig. 2, so that instead of having 180 degrees of belt contact on this pulley, he had only from 45 to 60 degrees, in fact, the belt just touched the pulley and was chasing itself around the idler pulleys in a rather circuitous path.

Current for Magnetic Chucks

In another factory the foreman complained that the magnetic chuck on the grinding machine they had recently bought of us would not hold their rings properly and did not seem to have very much holding power.

Our man asked if the wiring to the machine was all right so that the current passed through the chuck, and was assured that this was O. K. He then asked whether the current was direct or alternating. The foreman did not know. The next thing was to ask where the generator was. This was located in a corner under the stairs and when the dirt had been brushed off so that the name-plate could be seen, it was found to read 60 cycles, etc., showing that it was an alternating-current generator, and no magnetic chuck made will hold work on such current. Again the machine gets the blame, although our printed matter and directions for operating distinctly say that these chucks are to be connected to direct-current circuit only. If this is not within reach, it is usual to install a small generator to run from the same counter and furnish the small amount of direct current needed.

Another Error With Chucks

Another mistake that lots of shops make with magnetic chucks when they arrange them for holding the piston rings and similar work is to put iron disks in the center of the chuck to keep the rings from being pushed to one side and to center it so that it will run fairly true.

They seem to overlook entirely the fact that this disk absorbs the magnetism and robs the ring of its proper proportion of holding power. We always recommend using a fiber or wooden disk, but a brass disk can be used, as neither of these three materials will draw the magnetism away from the rings, but it is surprising to see how many good shops one will go into and find magnetic chucks fitted with iron disks in the center, and then the machine is criticized because the chuck does not seem to hold the rings as strongly as they think ought to be the case. We can multiply these instances indefinitely, but enough has been written to indicate some of the troubles makers of grinding machines are having, and to show some of the expense they are put to without any reasonable excuse apparently and also without any compensating advantages.

As stated at the beginning, we would like to hear from other parties in regard to the amount of expense and time a manufacturer should be called upon to spend in straightening out such matters and whether this expense should properly be charged to the purchaser of the machine or not.

Compound Dies for Sheet-metal Punchings

By K. S. Allen

Compound dies for this work are common, but some of the readers of the American Machinist may be interested in the details of construction of a pair of them. They are not far different from many others used by a large electrical firm where I was employed for several years.

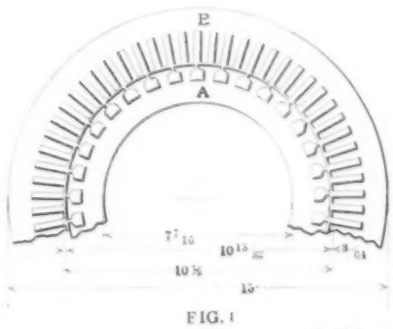


FIG. 1

FIG. 2

FIG. 3

PIECES TO BE PRODUCED

The peculiar feature, the one wherein they differ from similar dies made previously by this firm, is the getting of one punching from inside the other with so small an amount of stock between them. The punchings with their principal dimensions are shown in Fig. 1. They are each a complete circle. The material is 0.016 inch thick for most of them; a few are 0.028 inch thick; all are of soft iron.

The part *A* is one of the laminations of the rotating member of an alternating-current motor; *B* is one of the laminations of the stationary member of the same motor. It will be seen that *A* rotates inside of *B* after they are assembled with a clearance of 3/64 inch all round. There is no chance to do any machine work on them after they come from the dies. They are made in the following sequence: *B* is cut from a piece of sheet iron about 15½ inches square with the punch and die shown in section by Figs. 4 and 5. A segment of the scrap taken from the center by this operation is indicated by *C*, Fig. 2. It will be noted that it has a pilot hole in the center to locate it for the sec

ond operation in the punch and die shown by Figs. 7 and 8. The second operation cuts *A* complete, leaves scrap at the outside as indicated by *D*, Fig. 3, and the scrap left in the center is a simple washer 7 7/16-inches outside diameter with a 2-inch hole.

Referring to Figs. 4 and 5 it will be noted that the upper member is the die, while the lower member is the punch. Pins *E*, Fig. 4, are stripper pins and remain stationary. They are made especially for this type of die but are really a part of the press. Part *F* is a machine-steel stripper ring. Its normal position is resting on the nuts *d*, not against *E* as indicated by these drawings. The top plate *G* is of cast iron and of a size and shape suitable to bolt to the face of the press ram. Other parts are: *H*, a machine-steel disk; *I*, a shrink ring of machine steel; *J*, a shrink ring that supports *K*; *K*, a hardened tool-steel ring which forms one cutting edge of the die, having its inside diameter ground after the ring *J* is shrunk into place; *L*, a machine-steel stripper plate; *M*, one of the punches which cut the slots. See *B*, Fig. 1. They are made of tool steel hardened and ground. They are carefully placed in radial slots milled in the machine-steel punch plate *P*. Means to clamp them in position are provided while the plate *P* is placed on an arbor and its external diameter, punches and all are ground carefully to form a true surface for the ring *I*. After *I* is shrunk on the clamping fixture is removed and the inside of the punches are ground to suit the external diameter of *N*. In this group of parts *N* is a tool-steel taper ring hardened and ground inside and out; *O* is a machine-steel ring to support *N*; *Q* is a hardened tool-steel punch; *R*, Fig. 5, is a soft tool-steel die; *S* is a machine-steel stripper plate and *T* is a soft tool-steel punch which is made up in a whole ring. Fig. 6 shows a segment of this ring, its section and indicates how its face is concaved.

A machine-steel stripper plate *U* rests on pieces of rubber, not shown, and is retained in position by the studs *V*. A machine-steel bottom plate is indicated by *W*.

The lower stripper plate is *X*. It carries four studs *Y* which are screwed into the plate *S*. This plate *X* is bolted to an inverted tripod, which is a movable part of the press, although made especially for this type of work. The parts *X*, *Y* and *S* are raised by a cam on the press shaft at the right time to strip the scrap from the center. There are eight of the upper stripper studs *Z*. They are screwed tight into the plate *L* and are held from falling by a square, hardened tool-steel nut *d*. This nut is checked from unscrewing by a simple device *e*, a plan view of which is shown over Fig. 4. It consists of a brass strap wrapped around the nut with the ends reaching into a slot made for them. The nut can move vertically with the stud but cannot turn. The stripping is accomplished as follows: Pins *E* are set in such a position that the press ram on its up stroke lifts the ring *F* against them. This forces down *d*, *Z* and *L*, thereby stripping the work out of the die.

Referring to Figs. 7 and 8 *E*, *Z*, *d*, *Y* and *Y* are the same as in Figs. 4 and 5. All the other parts are similar to the corresponding parts in Figs. 4 and 5 and are indicated by the same letters sub-indexed. The materials are the same. The size and shape differ, only as is necessary to suit the punching *A*, Fig. 1.

Fig. 9 shows a segment and section of *T*. It is of soft tool steel the same as *T* in Figs. 5 and 6 and its construction is plainly shown.

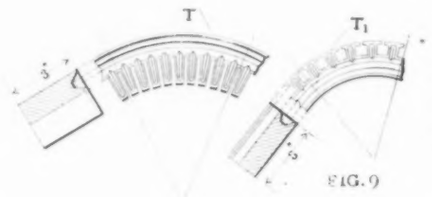


FIG. 6 FIG. 9

DETAILS OF RING PUNCHES

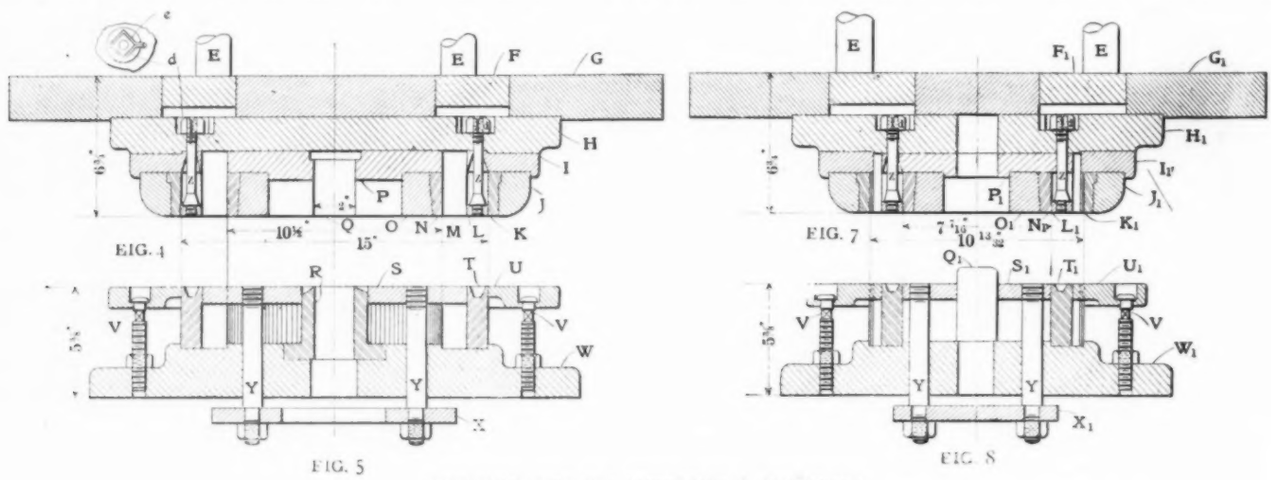


FIG. 4 FIG. 7

FIG. 5 FIG. 8

COMPOUND DIES FOR SHEET-METAL PUNCHINGS

Echoes from the Oil Country—The Importance of Standards

By W. Osborne

"What else?"

The salesman sat in the office of the superintendent. He was engaged in the pleasant task of writing down an order.

"I want some U. S. S. plug hand taps. 6 ½ inch, 4 ⅝ inch and 2 ¾ inch, and that will be all for this time."

"That is a very nice order and I am very much obliged to you for it. Just let me know one thing, please, and I will have everything down in good shape. What thread do you want on those taps?"

"I thought I told you to send me U. S. S. taps?"

"Yes, so you did, but I want to know what thread to send them."

The superintendent sat without saying anything for a minute while the salesman waited with pencil poised. It might be that the thoughtful look meant that something else was to be added to the order.

"What threads can you furnish them?"

"We can furnish you the half inch from stock with 12, 13 or 14 thread. The five-eighth with 10, 11 and I think 12—"

"You understand that it is U. S. S. that we are talking about?"

"Oh yes. And we can furnish—"

"Don't put yourself to any further trouble on my account. Just cancel that entire order, and never come back for another one as long as you are working for that house." The salesman looked up with a startled air. His friend, the superintendent, might be a joker, but he wished to keep on the right side of any joke that might affect an order. The look which he met was serious enough.

"I don't just see the point," he stammered, not knowing what it was best to say until he got his bearings.

"I thought I made it plain enough, but I will see if I can make it a little plainer. You are traveling for a manufacturing

house, and every man who is in authority in the firm ought to be taken out and tarred and feathered. This firm will never buy another dollar's worth from you if I can prevent it, and I think I can, and I will do everything that I can to keep others from having anything to do with you. There is just one man who ever called on me that I felt more like wanting to kick out of the office than I do you now, and that contemptible cur insinuated that the reason I would not buy his goods was because I was getting a rake-off from some other fellow."

The salesman was at his wits' ends. The superintendent was serious in what he was saying and well on the road to being angry. What it was that had set him going was more than the salesman could make out. He tried to run over in his mind everything that had taken place to see if he could have given some cause for the outbreak, but he could not think of anything.

"I am sure that I don't know what has gone wrong. I did not do anything to intentionally offend you, and am sorry that anything came up to make you feel less friendly than you always have up to now. If you withdraw the order that is your privilege, but I would certainly consider that you are doing me a favor if you will explain why you do so, for I tell you honestly that I do not know."

"I am willing to let you know that I stand ready to knife any firm who will mutilate the U. S. S. (United States Standard). Every firm that does should be driven out of the business. The U. S. S. calls for one thread and only one for each diameter just as much as it calls for the diameter and the shape of the thread, and anyone who makes anything else and stamps it U. S. S. is a reprobate and deserves a place in the rogues' gallery alongside of Benedict Arnold. He is a traitor to the mechanical world."

"If that is the trouble our house seems to be traveling with plenty of company, for every tap concern in the country does the same thing."

"I *think* that you are a liar, but before I say so I will give you a chance to look in the catalogs of some of the concerns who make taps, and if you prove that statement to be true I will apologize for what I am thinking of you."

He handed the salesman a catalog of a well known tap-making company. He had opened it at the place where it gives the illustration of the different shaped threads with their pitches. The salesman looked at it, found the same thing in the catalog of his house, and then went to looking through other parts of his catalog. Finally he looked up with a very red face.

"I guess you have it on me." He said. "I will have to admit being the liar and everything else mean in this combination, but you will have to clear the house. I see that they do not say that they make anything else but the regular U. S. S. I have been taking orders for years and asking that same question no matter whether they called for U. S. S. or not, and you are the only man who has ever said anything about it."

"I suppose, when a man gives you an order for a pipe tap you ask him what thread he wants, don't you?" The superintendent asked, sarcastically. "It is only one step further to ask the thread when you get an order for U. S. S. It shows that either you are very dumb or else that you think your customer is. I have found machinists who did not know anything about the United States Standard except that it was the mark on some kind of taps, just like B. & S. or P. & W., and I have felt a sort of contempt for their lack of information, but no wonder information travels around slowly when a presumably right-witted man traveling for a house that makes such goods carries around such dense ignorance with him. I don't know how you waste your spare time. You may play cards, drink booze or study French, but whatever you do you had better take a night or two off before you come around again and study the U. S. S. and a few other such things."

This superintendent was a man who had come up from the ranks. The troubles which come from lack of standards had been ground into him very thoroughly from the days when he used to go out on repair jobs and it was necessary to carry taps and screws 1/32 inch over size so as to be sure that the job could be done. He well remembers the talk he once had with the master mechanic of one of the trunk lines running through the State of New York. While doing a job for a large tannery concern he found that he must have two ⅝-inch nuts. Measurements showed that the studs were eleven threads to the inch. He was sent by the superintendent of the tannery with an order to the railroad shop where he found the master mechanic.

That worthy read the order and called to a man who was near, "get two ⅝ nuts and give them to this man."

"And please see that they are eleven thread," added the man who was to receive the nuts.

The master mechanic turned and in an impressive voice said, "young man, if you get any ⅝ nuts here they *will* be eleven thread. You should know that nothing else is made by reputable manufacturers, and a railroad such as this one could not use them even if they were made."

The look that came over the face of the man who had been told to get nuts was not one of respect for the master mechanic.

The master mechanic was a very busy man, and he rushed away on some of his numerous duties, while the man who wanted the nuts went along with the man who was to get them. They found ⅝ nuts of all sizes and many threads. If that master mechanic knew as little about the rest of the business of the road as he did about the pitch of the threads in actual use on that division it was not such information that enabled him to hold his job.

The man finally went back to the tannery with six nuts. They were all eleven thread, and about the same size on the outside but the range of diameters was great enough to allow him a chance of finding two that could be used on the job.

This superintendent also remembers the struggle he had with his own company when he wanted to adopt the U. S. S. for their screws on all new work. Doing so was not displacing any other standard, for none was followed. It was this fact that aroused the superintendent. He got numerous callings down because of the ragged appearance of some of his work.

On one job the bolts might not come through the nuts and on the next one they would stick through an eighth of an inch. A wrench forged to fit, say a three-quarter nut used on one part of the machine would not catch at all on one on another part of it and might be entirely too small for still another one. When an attempt was made to match up the nuts so as to get them all alike on the job it would be found that the sizes of the threads differed too much to allow it to be done. It is no joke when a man has to use nuts of the same nominal size, but which vary about ⅜ inch in outside diameter and ¼ inch in thickness and 1/32 inch in diameter of thread and yet all pass as ¾ inch. For all of the trouble a lack of standard was causing him he felt that he would not have carried his point if it had not been for two things. First, the U. S. S. goods did not cost any more, second, a U. S. S. tap was enough larger than a V-thread tap that often it would scrape up an old thread and make a good job without going to the next larger size. This was quite a point on repair work with set screws, cap screws and studs.

Even now he knows that he is looked on as something of a crank by his foremen when he insists on a finished piece being scrapped just because it is off size a bit when a piece could be fitted to it without any additional expense.

It is true that in most cases it would not make any difference to the man who got that machine if this was done, but the superintendent holds that it would have a tendency to lower the entire grade of all the future work turned out, and will not allow it.

This matter of having standards and sticking to them is an important one, and it is important that we keep those who make work for us up to where they belong if they show any tendency to get away from it.

Toolmaking in a Large Manufacturing Plant

Economical Production of Jigs, Dies and Other Appliances Made in Large Quantities by Various Toolroom Departments

BY H. C. BARNES

A large manufacturing concern, whose output was almost all light work, was suddenly confronted with such an increased demand for its products that it was compelled, on short notice, to increase the tool-room force from about 100 to over 200 members, and to increase the tool-room equipment proportionately. It will be sufficient to state that the best machinery that the market afforded was selected in every case.

With such an equipment, the devising of a comprehensive system to develop the greatest output of tools, with the required accuracy of workmanship, which in this tool room was exacting, was a task demanding large insight and sagacity. Such a force made a heavy pay-roll, while on a balance sheet of the company's books, no direct item of profit appeared. It was decided to employ a force of graded men. This force included a large number of toolmakers, a number of machinists, a group of young men with more or less experience on tool work, and some boys, most of whom had been in the works for several months at least.

The Gang Divisions

Naturally these men were divided into several gangs which took up the different kinds of tools; this constituted a number of departments for tool work. It was the sub-division of these departments and the method of distributing the work that made the result satisfactory, and demonstrated the wisdom of the method adopted. The leading departments in the tool room were as follows: The milling-machine force, the lathe force, the grinding force, the die makers, the jig makers, the screw-machine tool makers, the gage makers, the tap and thread-cutting die makers, and the hardening department, associated with which were the tool blacksmiths, or tool dressers. Besides these named, there were a number of men who made any special tools or fixtures that were ordered.

Tool Drawings

The completely detailed and reliable tool drawings which were furnished to the tool makers made this sub-division of the men possible. These drawings were prepared under the general supervision of the master mechanic. The force of designers and draftsmen was so large that it was also divided into groups, each group being under a sub-head who reported to the chief draftsman when necessity arose. The draftsmen were familiar with the shop processes and were required so to design the tools as to facilitate, as far as possible, their convenient construction. The designers of the special and automatic machines, of course, enjoyed greater freedom. The work was standardized so far as was practicable, and commercial parts were used where their use was advisable. In no case was any but the best construction considered. The drawings were all traced, and blueprints were sent into the shop.

Ordering Stock, Patterns, Etc.

When the blueprints reached the head foreman of the tool room he examined them and turned them over to a clerk. This clerk was always informed of the stock on hand, both in the stock room and in the general store-room. With this information in mind he made requisitions on these store-rooms for all the material needed for a job. This method of having one man order all the stock is better than having each draftsman take time to look up material as he makes the drawings. The latter course involves much loss of time and, as is frequently the case, when but a single fixture is made, a record of the stock used is of small value on the drawing. Such reports were made out in the shop record of the tool and its cost. When patterns were needed a blueprint was sent directly to the patternmaker. The steel work was crowded ahead while castings were being made. Materials were sent from the stock room directly to the men who would first handle them.

Progress Record

A complete card-index record of the progress of each tool was kept by a number of clerks, who entered from day to day the work done and its location in the different departments of the tool room. This record enabled the head foreman, who could not be expected to make mental record of all the work, to keep in touch with the progress of each tool, however small, until it was completed and sent to the inspection department of the factory. The inspection department was entirely independent of the tool-making department, and reported directly to the factory superintendent. All tools were passed by this department before they were used in the manufacture of the finished products.

The Milling Department

We now come to the actual work of making the tools and, in special cases, the assigning to each man the work that he was to do. All of the milling of any sort, except cutting the flutes in the small taps was done in the milling department. No milling machines were located elsewhere in the tool room. Standing orders were given that nothing should be planed, which was of a nature that could be milled. Since the planers and shapers were under the supervision of the foreman of the milling machines, there was never any dispute about machining the work of the department. The men were graded by their experience and skill. While the younger men and boys milled the plain cutters, which were made in large numbers, others, with more ability, did the more exacting work. Insofar as convenient the men worked on one class of work for a considerable time, thus familiarizing themselves with its requirements and reducing the time consumed. A list of these various divisions will be of no special interest. Sharp cutters were always ready for the machines when they were needed, and stock was always kept on hand and in advance of the men so that at no time was a machine idle, while the operator was engaged with some matter other than his appointed work. When practicable, steel parts were milled up in bars as long as the machines would finish, and then sawed off to the required lengths. This custom was not only a better use of the machine itself, since it did not cause all the wear to be at the center of the table, but also saved time in average costs. Cutters made of high-speed steel were used almost exclu-

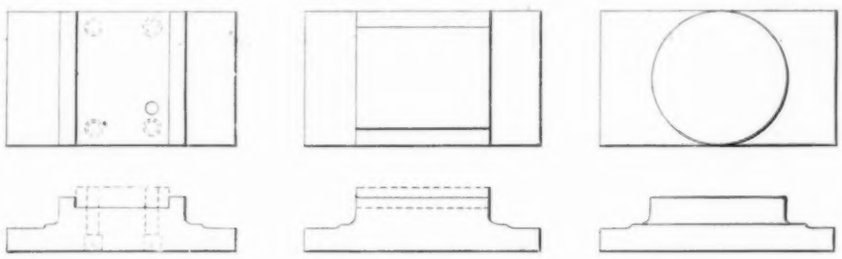


FIG. 1. DIE BLOCKS

sively. They were kept in condition by the grinding department.

Handling Lathe Work

The establishment of a lathe gang which should do practically all of the lathe work in the tool room was an innovation, but, under the supervision of a competent subforeman, it was found that uniformly satisfactory results were obtained from workmen who were classified by their ability. A large proportion of the lathe force were boys and young men. When the rough stock was sent to this department from the stock room, it was finished to size when the nature of the work permitted, but when necessary, enough stock was left for finishing by the man who assembled the tool. The distribution of the lathes differed from that of the milling machines, in that the lathes were not all under one sub-foreman. Enough were assigned to the different divisions to avoid confusion and delays in fitting or finishing turned parts.

Cutters, Dies, Etc.

Cutters, dies, jigs and assembling fixtures constituted the main output of the entire tool department.

All the cutters for the milling-machine department of the factory were made in the tool room. They were turned up, and when necessary they were backed off in the lathe department and were cut in the milling department. They were hardened and ground by the respective departments for that work. Special vise jaws were made for all work which could be in any way advanced by their use.

Types of Dies and Die Beds

The dies were of all kinds—cutting-off, blanking, piercing, forming, drawing, riveting, swaging, single, compound, single action, double action, and many of the high-class sub-press type. While these required a large variety of die blanks, beds, and punch holders it was found by experience that much of the work, especially much of the blanking and piercing, could be classified and accommodated by a few sizes of these main parts. Therefore they were made up in lots and kept in the finished stores. Fig. 1 shows three of the standard types of die beds, with some of the blanks in position as indicated by dotted lines. It also shows the method of holding them. The method is to mill the slot in the bed with its sides at 90 degrees with the base. The sides of the blank are square and finished so that the blank is pressed into the slot. Four screws are used, the bed being drilled and counter-bored for the screw heads, while the die blank is tapped entirely through. The screws reach through the blank. One dowel pin is enough to keep the blank in position. The stripper plate is mounted on the die blank in every case, so that when the die is ground the clearance between it and the plate does not change, as would be the case were the plate fastened to the die bed. In the stripper plate is set the stop finger. Ordinarily this finger is held down by a spring and is raised for feeding the stock by the downward stroke of the punch, an adjustable pin being set in the punch holder to touch the stop finger. This is illustrated in Fig. 2.

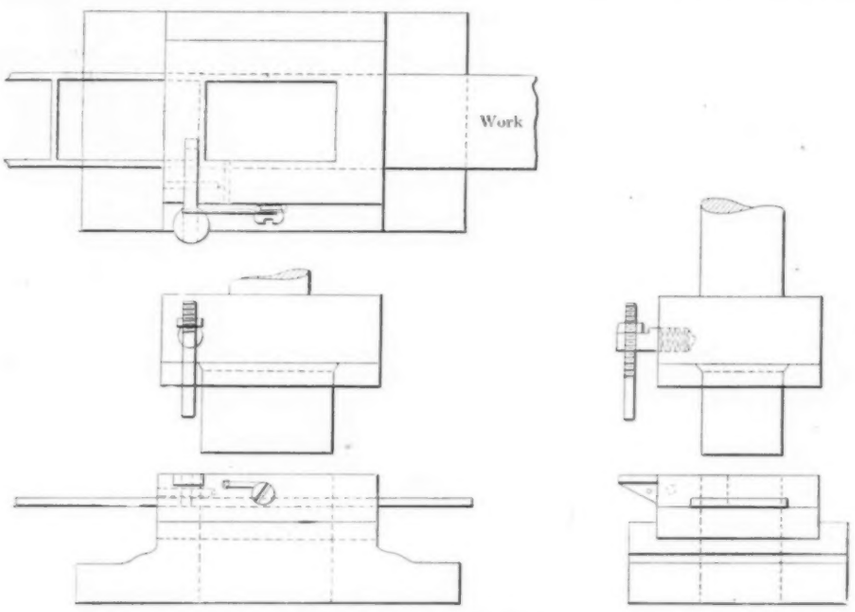


FIG. 2. PUNCH AND DIE

Holding Dies in Place

The common way of making dies with sides planed at an angle of 30 degrees and holding them by taper wedges, driven hard against them, often puts more strain on the die than the work of the punch creates. That system was not used here in a single case. Invariably a die was fixed permanently in its bed, and was not removed therefrom until it was discarded or worn out. The time consumed in once adjusting the type of die shown was generally worth more than the bed. When the cost of frequently changing dies is considered it will be seen that the method adopted was much cheaper than any other could be. For large dies to do heavy work, cast-steel beds were used. The bed was heated when the die was set in place. This seating was done in a large press, the die being held down until the bed became cool. Some objection was made to this method. It was claimed that the bed became distorted in cooling as shown exaggerated in the sketch, Fig. 3. But this argument was answered by the statement that whatever fullness appeared under the die was under its center, where it needed support. With a shrinkage of 0.002 inch, the actual distortion was not worth considering.

Machining Die Beds and Blanks

In machining the beds in lots, as already mentioned, they were clamped in a row on the table of a heavy vertical milling machine, first in one position, and then the other, and finished to size. This made the cost of finishing a single bed very small. The die blanks were cut from bars into strips as long as the plane-milling machines would finish them. A cut was taken over the sides, after which they were set up on edge, several being held together, and the edges were finished. Very little stock was left for fitting the dies into the beds when they were assembled. The finished strips were then sawed into standard lengths.

Machining Punch Holders

The punch holders for these regular sizes were also machined in lots. A large number were set up on the vertical milling machine with their shanks down. They were then finished on the flat side of the head. They were next mounted singly on the revolving table of the same machine where, with a large cutter, the top of the head and the shank were finished at a single turn of the table. The sides and ends were then finished, after which the punch holders were sent to the finished store-room. The cost of milling the shanks round was much less than would have been the cost of turning them on a lathe. Here also was a great saving in their price. Work was not begun on the steel punches until they were ordered. Their shapes varied so much that nothing was gained by taking them up twice to finish them.

Executing Orders

Occasionally, dies of unusual shape or size would be ordered. These would go through like any special work, but the subdepartment would generally handle them. On the fine sub-press dies, however, the

work was carried on more largely by a single man. Red tape was not permitted to stand in the way of common sense.

When a drawing for a die which was to be made was received in the tool room, the stock clerk, already mentioned, ordered the die bed, the die blank, and the punch holder from the finished stores if they were of the type and size kept on hand. If they were not in the finished store-room, they were ordered along with all the rest of the material which was to be milled for the job, and sent at once to the milling department. All the lathe work was sent directly to that department, while the screws and small fittings went to the die makers when the other parts reached them. In this way the work was well advanced before the die maker knew that the die was being made, and all the parts were delivered to him when he was ready to begin work on it.

Sub-division of Work

As the making of the dies with a force of more than 70 men was the most costly work in the tool room, the organization of that department required the most careful consideration. The highest standard of workmanship was demanded on all the work. The system that was established was as follows: All the die work was done under the supervision of a sub-foreman who, in turn, divided his men into groups of four. In each group and at its head was an experienced and reliable die maker; with him was a journeyman, who was also a first-class man; the third man was less experienced, working under instruction; while the fourth was a boy who did anything that he was given to do. The advantages of this system were many. In the first place, the sub-foreman's time was taken up by one-fourth of his men only, the other three-fourths being under the direction of the heads of the groups of four. These heads were selected because of their ability to direct the work of three others while they were themselves busy. This reduced the non-producers to a minimum.

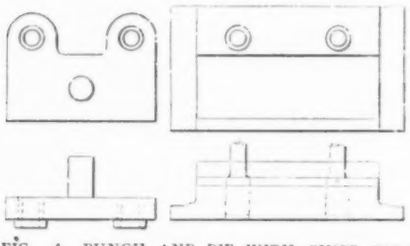


FIG. 4. PUNCH AND DIE WITH GUIDE PINS

Location of Responsibility

The chief, or head, was required to handle personally each die which went through his group; he gave out the work to his men as he chose. He was responsible for everything that went into each die, and with its proper adjustment and assembling. In effect, this system resulted in the work of 17 men going to the punch-press room, instead of the work of 70 men, with correspondingly less likelihood of variations, oversights and errors, so liable to occur among such a large number. Again, if a number of dies were unsatisfactory, it was easy to determine which sub-head was at fault. If several of the deficient dies were sent out by one man, the cause was found and remedied, or the man was displaced. Furthermore, when a die was called for on a rush order, any group of four, working as a unit, could finish it in much less time than four average men, unorganized, and with different ideas of the proper way to do the work. Thus the confusion and delay incident to their discussions and lack of coöperation were entirely avoided.

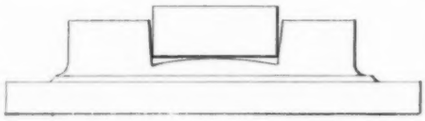


FIG. 3. DEFORMATION OF DIE BED

Press-tool Drawings

In making the tool drawings for the special drawing and forming dies, no attempt was made by the draftsmen to guess at the shape of the punch and die which would produce the result wanted. The drawing would show the form as if there was no spring in the material used, so that the die maker could get that result without hindrance, enough stock being left on the several die parts to permit them to be worked into proper shape. The die maker was also required to "find" the shape of any blank which was to be drawn in a forming die.

Guide Pins and Bushings

In the dies wherein liner pins were used, as shown in Fig. 4, the punch and die were made and assembled in the regular way. The punch was then set into the die and clamped true against parallels. The two were next mounted on an angle plate on the table of a milling machine, care being taken to have everything square. The holes for the pins and bushings were then bored at one setting. Hardened and ground tool-steel bushings and pins are the best and generally the cheapest to use, as they will hold their form under pressure. If bronze bushings are used they will compress when they are forced into the holes in the punch holder. Then they will not slide over the pins. Reaming them to size is the only recourse, but this is liable to disturb, if only a little, the alinement of the holes. Unless the bushings fit entirely around the pins their efficiency is reduced to practically a two-, three-, or four-point bearing, according to the number of pins used. Under these adverse conditions looseness will soon develop in the bushings. This makes them entirely worthless. In making the liner pins care must be used to avoid having them so long that their tops interfere with the plunger of the punch press during its stroke.

For many purposes the use of these liner pins in plain dies is much more convenient than the use of dies of the more expensive sub-press type, when that type can be made, while for heavy work where a sub-press die is not practical, the liner pins are invaluable. Two or more pins may be used as necessity requires. The cost of inserting the pins and bushings is not enough to consider, when one realizes that a single shearing stroke of the punch, caused by either accident, or carelessness, may spoil an expensive die. While this reference to the liner pins is really a matter of tool design, its importance, in view of its exacting demands on the toolmaker is of paramount interest in the tool room.

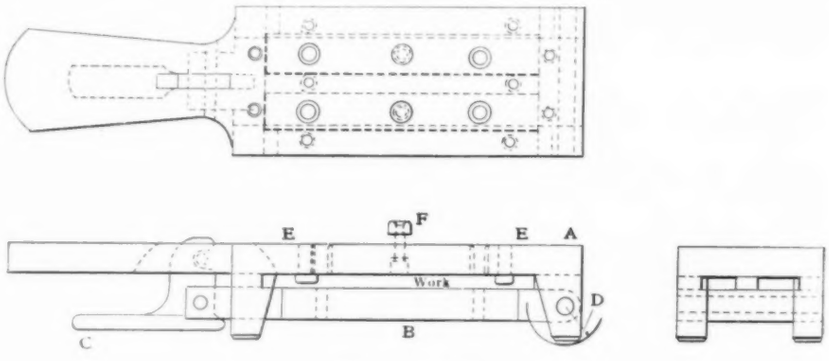


FIG. 5. LEAF JIG

Types of Jigs

As with the dies, all jigs were subjected to close inspection, and were required to measure within close limits. The jigs comprised mainly three classes, although for special work suitable jigs were provided. Except in special cases, the jigs were made entirely of machine steel, cast iron being too perishable to stand the long and hard usage which they received. The three general types were leaf jigs, strip jigs and plate jigs.

Leaf Jigs

The leaf jigs, Fig. 5, were composed prin-

cipally of a body *A*, with a solid handle; a leaf or swinging plate *B* which supported the work while it was being drilled; and a latch *C*, which snapped over a pin in the body, and held the leaf. The bodies were largely standardized so that they might be kept in the finished store-room. The smaller sizes were milled out of a solid bar which was cut as long as the milling machine would finish it. They were then sawed apart and what individual work was necessary was done with the jigs in series. The larger jig bodies were milled in pairs or singly. The leaves were made in bars and sawed apart. The latches being drop forgings, needed but little finishing. Hardened-steel shoulder pins *E* were favored as a means of locating the work in the jig, as they were easily located when the jig was being bored, and they could be renewed when worn. A special feature of this jig is the "knock-out" *F*. When the piece in the jig is drilled, the jig is turned over so that the leaf and latch handle are on top. The leaf is raised and the entire weight of the jig with some added force, if necessary, is put on the head of the knock-out. This presses it through the jig body and thus lifts the work from between the shoulder pins. The bushings were usually made on a screw machine in lots. These were hardened, the hole being lapped, and the outside ground true with the hole. They were then sent to the finished store-room.

Jig Construction

The manufacturing process for the jigs was generally similar to that for the dies. With few exceptions, the jigs were bored on a vertical-milling machine with a spindle which moved up and down and which was provided with vernier scales on the table and the cross slide. Specially adjusted magnifying glasses made the reading of the verniers easy while small electric lights shone directly on the scale and prevented shadows. Special men became adept in boring the jigs quickly and accurately. Standard drills, reamers, and centering tools with taper shanks to fit into a sleeve in the spindle of the milling machine were used. A special boring device with an adjustable blade also fitted into the sleeve. On some of the jigs the holes were not bored, the drilling and reaming being sufficiently reliable.

After the holes were bored in the body it was sent to the jig-making gang to be assembled. The leaf and the latch were put in position and the holes drilled for the pins. The pins and the adjusting screws, if any were used, were put in place. Then the bushings were driven in and the mill sizes, together with the shop symbols, were stamped on the body. Clearance holes for the drill were made in the leaf, after which the complete tool was sent to the inspection department.

Finishing Operation

Ordinarily the jig was passed without criticism, and returned to the jig makers. Then, if the nature of the work permitted, the jig was taken entirely apart, and the body, leaf and latch were sent to the hardening department to be case-hardened. While this hardening process caused some change in the shape of the jig, the change between the holes was slight. After the hardening, the tool was reassembled. If the small change in shape was not permissible a hardened steel plate, properly drilled and stamped, was screwed on the top of the body to prevent its mutilation by careless operators in the factory.

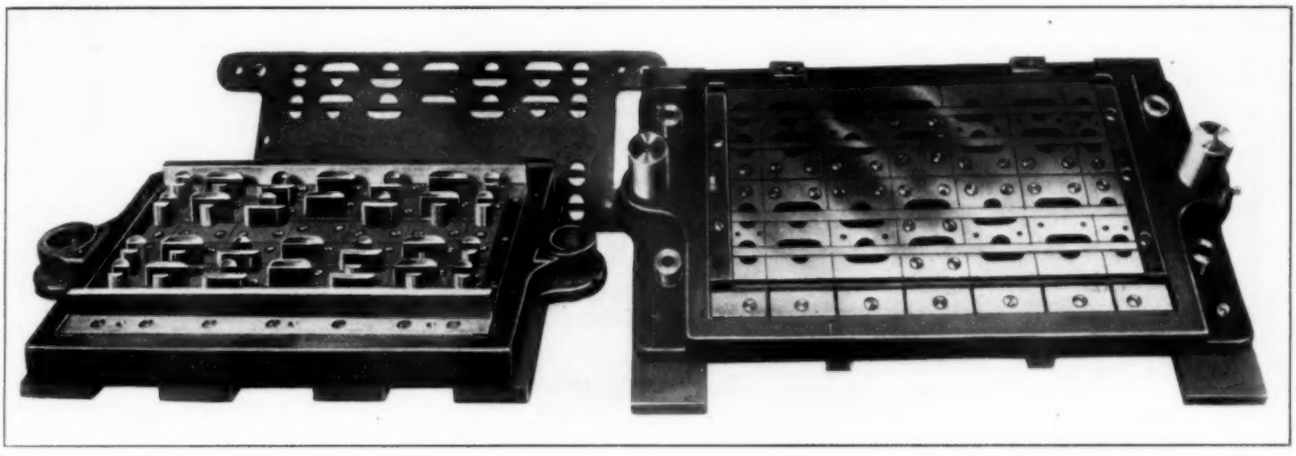
The operations of the other departments were generally similar to those described. These several departments were under the management of men chosen for their knowledge and executive ability. The several heads assigned the work to their men according to their skill and training and in this way maintained a high rate of output for the respective departments.

It is estimated that under normal conditions the annual production of the Scotch steel trade amounts to about 1,000,000 tons.

A Remarkable Sectional Die*

The half-tone illustrates a remarkable punch and die, designed and made at the shops of Edward Board, on Filbert street, Philadelphia, Penn.

The punch and die shown were constructed for making a large number of openings in sheet steel, and in the die alone there are nearly 70 parts, including the series of clamp blocks along the sides of the die sections. The method of locating and securing the die blocks in the main holder is plainly indicated. The blocks are held in place by fillister head screws, and they abut against one another, and are pressed firmly toward the back of the frame in which they are secured by the series of plain blocks in front. These latter have a slightly beveled edge contacting with a similarly beveled edge in the front of the holder. Each of the punches is doweled to a holding block planed out to the same section as the punch so that the back face of the latter is flush with the back face of the holding block. The block itself is secured to the main punch holder by a pair of fillister head screws, and the whole series are pressed firmly together by the clamping strip at the front which takes a bearing against the beveled surface inside of the main holder. The stripper plate will be seen at the back of the punch.



SECTIONAL PUNCH, DIE AND STRIPPER

Each of the punch and die members is ground dead square on ends and sides, and they fit perfectly one against another. It is obvious that this construction admits of any rearrangement desired; that is, if different groupings of the openings in the work were desirable, the punches and dies could be rearranged for the new combination. The die measures about 15x22 inches.

This plan can be used to advantage in many places and deserves to be better known.

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An Analysis of Machine-shop Methods

The Government Has No Monopoly of Inefficient Shops. Inefficiency Often Due to Day-work, Lack of System in Tools, Material and Organization

BY HOLDEN A. EVANS*

The belief that all Government shops are inefficiently managed is very common among managers of commercial industrial establishments. It is acknowledged that there is not the all-powerful incentive of dividends in a Government shop, also that Government shops labor under restrictions not common to commercial establishments. On the other hand it must be admitted that the Government has no monopoly of the inefficient establishments.

It is my opinion that the methods followed in some Government shops are equally as good as those followed in the best of the "day work" commercial establishments. I have had the opportunity of comparing the machine-shop methods followed in some of the largest shipyards in this country with those which will be described in another article, and I have no hesitation in stating that the results obtained in the Government shop are at least equal to those obtained in these shipyards.

Causes Tending to Inefficiency in Government Shops

The officer in charge of a Government shop who wishes to manage it in the same manner as he would were he in commercial life, where the payment or non-payment of dividends would measure his success or failure as a manager, has some difficulties to overcome which he would not meet elsewhere. In the Government service the reward for meeting and overcoming these difficulties is so meager that few are tempted to wage the necessary fight, as such a fight is replete with many dangers, and if successful the reward is little more than the self-satisfaction of the knowledge of "duty well done." This is one of the important reasons why the results obtained in some Government shops are not equal to those obtained in well-managed commercial establishments.

It is not many years ago that the navy yards were run as a part of the political machine and the positions in the yards belonged to the successful political party. With each change of administration there was a change not only of all the foremen, clerks, etc., but also of the mechanics, and even down to the lowest paid laborer. A head of department employed only such men as were designated by the politicians. Under these conditions it was useless to aim at efficiency. By placing the navy yards under civil service rules this most serious defect was remedied, but at some cost. Under these rules all labor at each yard is employed through a central labor bureau. Men desiring employment are registered upon presentation of character and trade certificates, and are taken on in turn (subject to preference given veterans) as required. These rules are rigidly enforced and it is now impossible for the most powerful member of the Senate to get employment for a man out of his turn at any navy yard. These rules have made possible an improvement in the efficiency of navy yards, and have been of the greatest benefit; there are, however, disadvantages, as the same rules prevent a head of department from employing the most efficient labor; he must take the men sent to him by the labor bureau. He can, of course, reject those that are manifestly unsuitable for the work, but he does not have the privilege of selecting his men, nor can he hire a specially qualified man for the work. This man may be the best in the country, but he must register and take his turn. If there are many registered, which is usually the rule, it may be years before his name is reached. What commercial manager would like to undertake the management of a large establishment without the privilege of selecting his workmen? This is a necessary handicap which the navy yards must suffer; for, if the civil service rules are not strictly enforced, politics will surely creep in and efficiency and politics seldom go hand in hand.

There are other difficulties in the way of efficient management in navy yards, the most important of which will be briefly noted:

Influence of Labor Unions

(a) A head of a department who attempts to run his department on a strictly business basis will immediately run afoul of this influence. Let him attempt to correct the fault common to so many Government establishments—the use of highly paid mechanics on inferior work—by putting helpers and laborers on such work; let him try to reduce the number of highly paid mechanics who are doing work that can as well be done by lower grade men; let him discharge and reduce the ratings of men when merited; let him attempt to increase the output by having a report each day of the work accomplished by each man; let him attempt piece work or premium work; let him introduce the stop watch; let him put into effect many of the economics so necessary to successful management and he will at once feel the influence of the unions. Countless reports will be made against him to the navy department; every influence will be brought to bear to have him

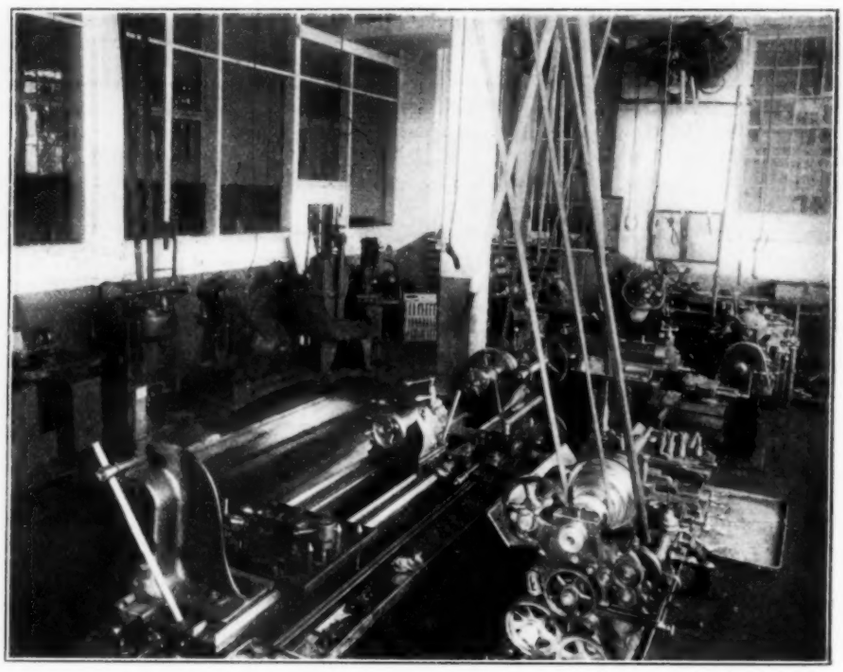


FIG. 1. TOOL ROOM

*Naval constructor, United States Navy, Mare island, California.

removed, and failing in this, every effort will be made to discredit him with his superiors; and a newspaper crusade will be carried on against him if the navy yard is located in a small town where the unions have a strong influence on the press. Managers in civil life can hardly realize the difficulties of such a position. The temptation to take things as you find them and avoid this endless strife is very strong.

Poorly Paid Foremen

(b) As a general rule the Government pays inferior and mediocre men much more than they deserve, while the best men are usually underpaid. The pay of foremen is so small that men with the necessary qualifications cannot usually be secured. For example, in the department under my supervision the foreman machinist is in charge of not only the shops,

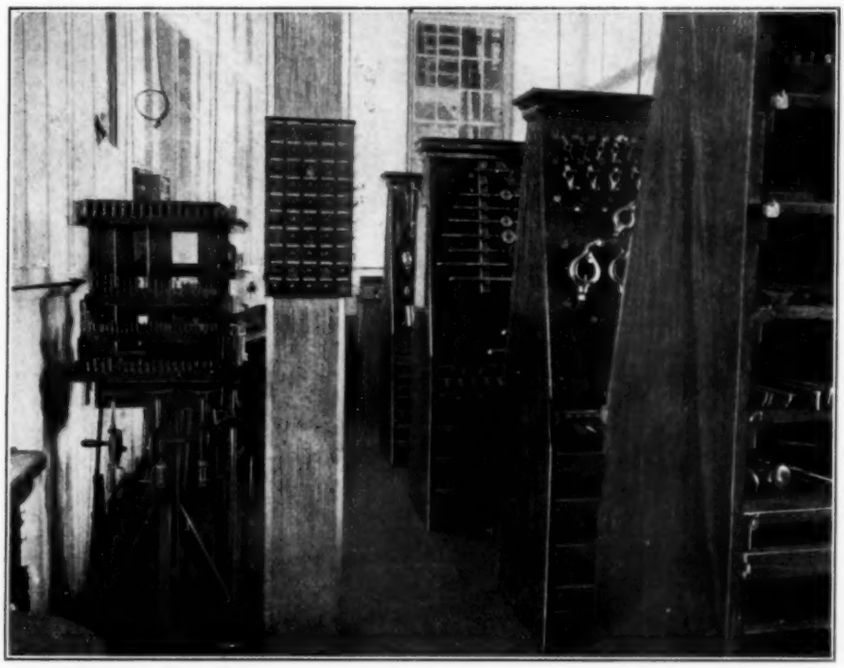


FIG. 2. TOOL SUPPLY ROOM

but also of the outside machinist work on ships under repair. He has under his supervision from 150 to 200 men in the trades of machinist, die sinker, toolmaker, pipefitter, plumber, coppersmith, and galvanizer, the first-class mechanics of which receive from $4.16 to $5.04 per diem, while the foreman's pay is but $6 per diem.

(c) The feeling among many workmen that there is no necessity for working anywhere near their maximum capacity in a Government shop.

(d) The rating of men in four classes and allowing no deviation from the rates of pay fixed.

(e) The many restrictions in a Government shop do not give the head of department the freedom of action so essential to the highest measure of success.

(f) The use of high-class, highly paid men for inferior work.

This is a fault common to nearly all Government establishments. In many such shops drill presses, grinders, turret lathes, bolt machines, molding machines, engraving machines, and machines of like character are run by mechanics receiving high wages. It is my experience that for work of this character far and away the best results can be obtained by taking energetic, ambitious, young helpers and making operators of them, holding out to them as an inducement an increase of pay of 25 cents to 50 cents per day when they are able to give a stated large output. An attempt to correct this defect in organization always meets with much opposition from labor unions.

The "Day Work" System

(g) In all navy yards all machine work is done under this system, and consequently the best results are not obtained. At the Brooklyn yard, after much opposition on the part of the unions, piece work has been established for certain portions of structural work such as riveting, drilling, chipping and calking, laying off, and anglesmith work. Lately, at the Mare Island yard, under my supervision, piece work has been established for riveting, chipping and calking, laying off, anglesmith work, erecting, punching, planing, bolting up, drilling, reaming, wood calking, painting bottoms of ships in dock, and laborers' work of scaling ships with pneumatic hammers.

After a thorough study and investigation of the subject, I am convinced that work in the machine shop and foundry in a navy yard can best be done under the Halsey premium system rather than the piece-work system. I have been much impressed with the teachings of F. W. Taylor, but, after full consideration of Mr. Taylor's system, Mr. Halsey's system and modifications of the latter, I am convinced that for navy-yard work Mr. Halsey's system is the most suitable of all those now used in the most modern shops. A navy-yard machine shop and foundry are jobbing shops in the highest sense of the term. Men-of-war are today very complex machines, filled with every class of machinery; no two ships are exactly alike; no two are subject to the same ills. The repairs to ships, which is the principal work of navy yards, calls for every class of work in both the machine shop and foundry, thus the fixing of piece-work rates is most difficult under favorable circumstances where the services of an expert rate-setter is available. In a Government establishment it is impossible to obtain the services of such an expert. The fixing of standard times is much easier; an error in these times is not of such serious consequences as an error in the piece-work rate. Furthermore, the establishment of the premium system will not excite so much opposition as the piece-work system. I, however, believe that stop-watch time studies, as advocated by Mr. Taylor, can be used to great advantage in fixing standard times for the premium system.

General Causes of Inefficiency

In addition to the causes of inefficiency enumerated above, which are usually found only in Government shops, these shops are subject to the causes of inefficiency common to private shops. These causes will be enumerated with some comments. These comments are explanatory of the description of the methods in the shops under my supervision, which is to be given in another article. This procedure is followed, as it is desired to give the shop instructions exactly as issued to the shop, and some explanatory notes are necessary for a better understanding of the defects that the instructions are intended to correct.

Loss of Time Waiting for Work

(a) In many shops the losses due to this cause are very large. In these shops, both Government and private, there is no system by which the workmen are automatically, as it were, supplied with work and material. There is no routing system; the shop foreman and his assistant, if there is one, are simply told to "run the shop," and it is left to them *how* to run it. The foreman is to see that the men are supplied with stock, to assign them their jobs, send the work to the machines he thinks best suited for the job, give the men instructions as to what is to be done and how to do it, see that proper tools, jigs, etc., are supplied, keep the tools and appliances in good condition, see that proper feeds, speeds, and cuts

are used, order castings from the foundry and forgings from the smith shop, rate the men, look out for the discipline of the shop, charge up the men's time to the various jobs, etc. Does he do it? The answer to this is best found by taking any *one* of the duties above enumerated and fully investigate and see how far short he is in doing what should be done. Ask him what speeds, feeds, and depth of cut should be used on a lathe and on a planer for various classes of work. Get his answer and then see what is actually used. Ask the assistant the same questions and the answers will probably vary by 100 per cent. Stand in the shop and watch him run from one thing to another; only the *immediate* necessity receives his attention. See the men waiting for jobs, or killing time pretending to clean their machines, or some similar work while a job is found for them. See the workmen go to him for some needed information to continue their work, or to tell him that the material is not in the shop for the work.

This description can be continued to considerable length, but it is believed that the above will suffice. This is no exaggeration. A careful examination of many shops will reveal these conditions.

It is needless to expect a foreman to "run the shop" efficiently under such conditions. It simply *cannot be done*.

The loss of time due to men waiting for work or material is very large. The best men in the shop, if they finish the job on which they are working an hour before quitting time, will not go to the shop foreman for a new job; they will clean their machine, or go to the toilet, or grind their tools, or do something of this kind to kill the hour. The next morning they go to the foreman to hunt up a job. The poor men will kill time just as long as possible, pretending to do something to hide the fact that they have no job, feeling secure in the excuse that they are waiting for the foreman to come around to give them a job. The foreman in many instances knows this, but he is busy getting material for some urgent job, or attending to some important rush work, and has no time to hunt up a job with the attending work of getting material, drawings, etc., for the idle machine. In other words, he is giving his attention to the most urgent work and all the rest of the work must suffer.

I am satisfied that there are few improvements which will give such immediate results as the establishing of a good routing system which will supply each workman with work and material, and eliminate the *waits*. In the average shop this will in itself increase the efficiency of the shop from 10 to 20 per cent.

Losses Due to Insufficient or Improper Instructions

(b) Due to causes described in (a) above, the foreman frequently assigns a job to a machine and gives hurried, verbal instructions as to what is to be done. Very soon the workman finds that there is some further information needed to enable him to proceed. He waits around awhile and the foreman does not come, so, if he is a good man, he goes to the foreman and finds him engaged in making up a list of material, or an estimate, or giving instructions about some urgent work, and he is told to go back to his machine—"I will be there in a minute." The foreman is called away for something else and he forgets the waiting machine, and the minute grows into the hour, or even a day. The workman feels that he has done his full duty and "kills time."

Or the workman may misunderstand the instructions given and machine to wrong sizes. When this is discovered after the work is completed a controversy is started between the man and the foreman relative to the verbal instructions. This is usually settled by the piece being hidden and a new one made, unless it has been discovered by the superintendent or manager, which is necessarily a rare case. Little is known of the extent of the losses under this head. Start a "damage report," as I will subsequently describe, without making any other change in the shop system, and see that it is absolutely enforced, under pain of instant discharge if the report is not made. Then see how many reports come to the desk, and count up how much money is wasted.

No Records of Damaged Work

(c) When the workmen and supervisory force know that there is little or no accountability for damaged work, or damaged machines, and that the crime is in being caught, it is safe to assume that the loss due to damaged work is much greater than it should be. The knowledge that a written record is kept of all work or machines damaged will surely make everyone more careful.

Losses in Grinding and Getting Tools

(d) The gain in efficiency due to grinding tools to a standard and not to the individual fancy of each man, to say nothing of the loss due to men hanging around the grinder waiting their turn at the stone, is so well recognized by all who have had any experience in shop work that it is not necessary to dwell upon it. The importance of supplying the tools to the men at the machines, however, is not so well recognized. Tools properly ground are kept in the tool room, and in many shops the men go to the tool room themselves to exchange the dull tools for sharp ones. This should not be allowed. The tools should be supplied to the machines by a boy, who will save his pay many times over. If proper shop methods are followed a man leaves his machine for but one thing—to go to the toilet.

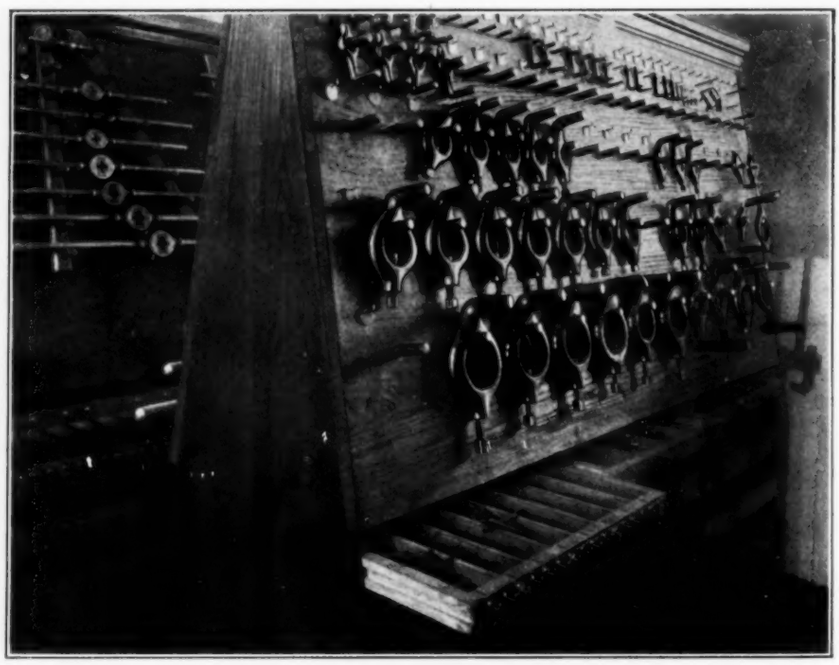


FIG. 3. TOOL SUPPLY ROOM

Poor Tool-room Equipment and Methods

(e) The tool room is properly called the "heart of the shop." Without an efficient tool room an efficient shop is almost impossible, for without good tools good work at low labor cost cannot be accomplished. An ingenious, wide-awake head toolmaker is cheap at almost any price, for on him the shop must depend for its labor-saving tools, jigs, and appliances.

In reorganizing the machine-shop tool room and laying out the space for the tool-supply room and tool room three years ago, I thought that I realized the

possibilities of the tool room and had provided ample space and facilities. I now find that additional space will soon be required to provide additional needed facilities. The half-tone illustrations, Figs. 1, 2 and 3, show clearly the arrangement of the tool room and the tool-supply room, and also the arrangements for storing the tools in the tool-supply room.

An *up-to-date* card inventory is kept of all tools in the tool-supply room. A double check is kept of all tools issued. There are checks provided for all the tools in the room; these are stamped with the name of the tool and hang on hooks on the drawer or slide containing the tool, or alongside the tools on pegs. There is a board numbered with the check numbers of the men employed. A man wants a tool—say a 7/8-inch twist drill—his brass check is taken and is hung on the hook on the drawer in which 7/8-inch twist drills are stored, the drill is issued and the check marked "7/8-inch twist drill" is taken from the hook on the drawer containing the drill and is put on the board under the man's number. At any time by looking at the checks on the man's number it can be determined what tools have been issued to the man, or by looking at the checks hanging on the drawer containing the twist drills it can be instantly determined who has the drills.

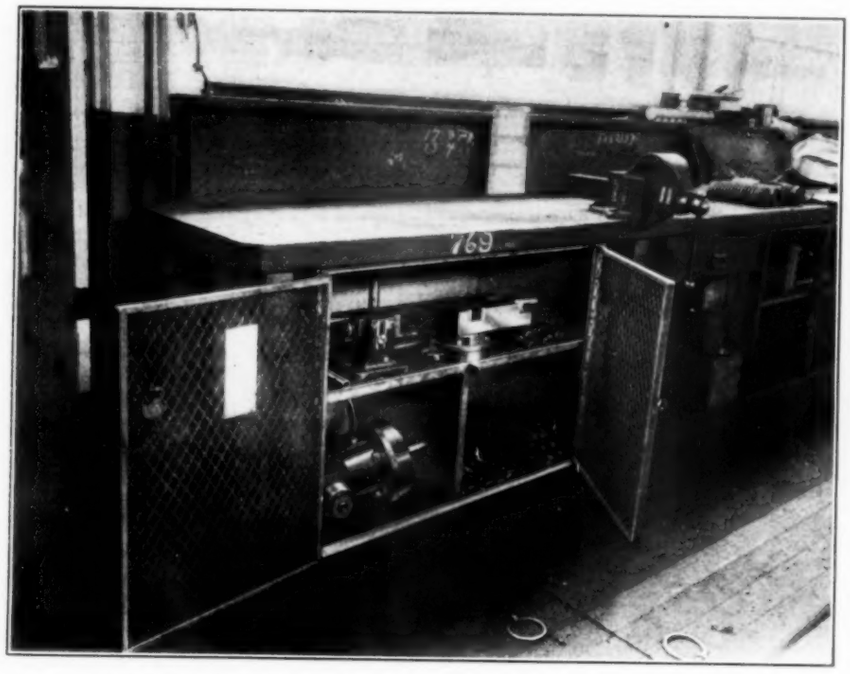


FIG. 4. LOCKER FOR APPLIANCES FOR EACH MACHINE TOOL. THE LIST OF APPLIANCES IN EACH LOCKER IS SHOWN ON THE DOOR

Tools turned in by the workmen are not immediately returned to their racks; they are given a casual inspection when turned in to see that they have not been damaged or broken before the workman's check is returned, and then placed in a "tote box" at the window. These boxes are taken to the tool room adjacent and the tools are there carefully inspected and reground or adjusted as necessary and then returned to the tool-supply room to be placed in the racks. Broken tools are expended from the inventory by entering them on the back of the inventory card. An entry is also made in the "broken-tool book" against the man who broke the tool, and at the end of each month a list of the tools broken, with the names of the men who broke them, is made up and posted on the shop bulletin board. This shows up to everyone the men who habitually break tools. The breaking or damaging of a valuable tool is reported by the tool room to the foreman, the cause of the damage is investigated and a damage report submitted. Workmen should not be led to believe that the breaking of the ordinary tools used is considered a serious offense, for if this is done the men will be afraid of their tools and will not drive them as they should. On the other hand, habitual carelessness should be punished. It is believed that the methods followed afford a satisfactory middle course which will obtain the best results. From the "broken-tool book" each man's record with tools is determined, and if this is not good, an entry to this effect is made in the record book in the foreman's office.

Poor Condition of Machine Tools and Appliances

(f) In a "day-work" shop, where there is little or no incentive to the men to turn out the maximum amount of work, the condition of the machine tools is very apt to run down unless special measures are taken to correct this tendency. In a piece-work or premium shop, where the men are directly interested in the output of the machines, they will be kept in the highest state of efficiency if the men's wishes are followed. In a day-work shop many men will let their machines go from bad to worse, with a continually decreasing output, without reporting the fact until a complete break-down or stoppage of work makes a report necessary. In the premium shop, if there is any anticipated trouble with the machine the workman will report it in order that it may be remedied before the output is decreased.

Tools in a navy-yard machine shop require close care, as there are many that are only occasionally used and how often is it found that these tools when wanted for a job—perhaps an urgent one—are not ready for use and several hours', or even days', work is required to get the machine ready. The tools in constant use are subject to the conditions described for "day-work" shops and are not usually kept in the highest state of efficiency. To correct these conditions is one of the objects of the system followed and attention is invited to the description of the duties of the "head toolmaker" and the "repair man."

It is the "repair man's" duty to keep a close watch on the condition of the machine tools and he must not take up any work that will prevent him from doing this. While he is to make all *ordinary* repairs himself, this does not mean that he is to undertake work on a machine which will occupy him several days; for these jobs he is to call on the head toolmaker for assistance from the tool room. The repair man is made directly responsible for the condition of the machines and he is held to a strict accountability if the machines are not kept in the very best condition. Again, the system followed drives the tools very much harder than previously, and the speed boss is responsible that the standard feeds, speeds, and depth of cuts are followed. If the machines cannot stand the work *he* is responsible unless he has brought to the attention of the repair man the condition of the defective machine.

The appliances that should be supplied each machine do not usually receive proper attention. In the usual shop with some machines lying idle, if a man at a machine wants a dog or a bolt or a clamp the easiest way for him to get it is to go to the nearest idle machine and help himself. This is what he usually does, except that he often takes two if available and stows one away near his machine for possible future use. When the idle machine is wanted much time is lost in supplying it with the necessary equipment. Again, a new man is taken on and put at one of the idle machines and given a job; he does not know the shop and he hunts around for the necessary equipment and after losing considerable time, goes to the foreman, who will send him to the tool room, where he will probably be told that the appliance is with the machine. Then he goes from one man to another, trying

to get the necessary equipment. After finally succeeding in starting on his work he finds something else missing; he has to go through the same thing again, and so on until he learns to go to the nearest idle machine and see what he can pick up. By this time he has lost much time and has given the impression to the foreman that he is a very poor sort of machinist, for he could not take the simple job given him and do it without bothering everybody in the shop, and he is so reported.

These conditions have been corrected by supplying each machine tool with a full equipment. This is placed in a metal locker near the machine and a list of the appliances is put on the door of the locker. This locker is locked. When the machine is not in use the key is kept on a board in the tool room. When a workman goes to the machine he gets the key from the tool room by leaving one of his brass checks, just as is the case with a tool issued. When he leaves the machine he cannot get back his check and get "clearance" until all articles in the locker have been checked against the list on the door by the repair man, the locker locked and the key deposited in the tool room. The half-tone illustration, Fig. 4, shows clearly the contents and character of the locker.

Poor Belts and Lack of Proper Upkeep

(g) In the average shop there is much loss of time due to stoppages on account of poor belts. There is also considerable loss in the efficiency of the machine from the same cause. In the machine shop under my supervision, before this subject was taken up and systematic care taken of the belts stoppages were frequent, and the loss of time due to this cause was considerable. At the present time a stoppage due to a bad belt is a rare occurrence.

No System for Routine Work

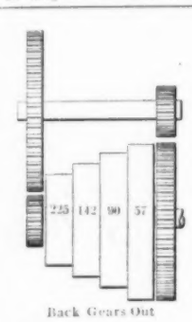
(h) The usual procedure in many shops is for the shop foreman to assign work to a machine; when it is finished look around to see what man on the next type of machine has run out of a job and then assign him the next operation, etc. This system, or rather lack of system, causes much loss of time and makes the work cost much more than it should. It is also found usually, when assembly begins, that some operation or part has been forgotten and the whole job waits while this work is done. An efficient routing system where the work automatically moves from machine to machine is essential to an efficient shop.

Lack of Adapting Machines and Methods to the Work

(i) Where the usual methods referred to in (h) are followed little consideration is given either to the *best machines* for the job or to the *best methods* of doing the job. The best machines for the work should be carefully selected by the "planner" when he is planning the whole series of operations required in the machine shop. To assist him in this work he has at hand the records of past work in the various machines. The best methods are decided by the gang boss and speed boss. It will be noted in the detail instructions given later that the gang boss does not wait to settle the best methods until the workman is ready for the job and is waiting while the gang boss decides on the methods, tools, etc. The methods followed require the gang boss to settle this question and also provide all necessary jigs, tools, drawings, etc., before the workman is ready to start on the job. The speed boss is required to drive the work through the machines in minimum time.

Now, jobs are not started until all forgings and castings for the whole job are in the shop unless it is urgent, and even then there must be enough ahead to keep the machines going until the remainder of the order comes in. It is recognized that sometimes in cases of breakdown, or a job that is very urgent, work must be taken out of a machine to give place to the urgent work. These cases, however, are rare, particularly in a Government shop, where there are usually many tools that lie idle for a great part of the time. Often jobs are called "urgent" and when analyzed the "urgency" is caused by the neglect of someone. Cases of this kind come up every once in a while. The out-

36" Engine Lathe No. 499, Mfg. by Fitchburg Machine Works — Speed of Countershaft, 113 R.P.M.



Dia. of Work in Inches	Revolutions of Spindle							
	225	142	90	57	25	16	10	6.3
	Cutting Speed in Feet per Minute							
½	29	18	12	7	3	2	1	1
1	59	37	23	15	6	4	3	2
1¼	90	57	36	23	10	6	4	3
2	117	74	47	29	13	8	5	3
2⅛	146	92	58	37	16	10	7	4
3	175	111	70	44	20	12	8	5
4	236	148	94	60	26	17	10	7
5	292	185	117	74	32	21	13	8
6	351	223	142	90	39	25	16	10
7	412	260	165	104	46	29	18	12
8	470	297	188	119	52	33	21	13
9		335	212	134	58	39	23	15
10		370	234	148	65	41	26	16
11		410	260	164	72	46	29	18
12		430	279	177	77	50	31	20
13		482	306	194	85	54	33	21
14			330	209	92	59	37	23
16			377	239	105	67	42	26
18			424	267	118	75	47	30
20			470	296	130	83	52	33
25				370	152	104	65	41
30				445	195	125	78	49
36					235	151	94	59

FIG. 5. SAMPLE OF DIAGRAMS AT MACHINES SHOWING CUTTING SPEEDS FROM DIAMETER OF WORK AND LOCATION OF BELT ON CONE PULLEY

Insufficient Material — "Breaking-up"

(j) This is a common fault and is one that is productive of much loss of time. It takes some time to get a machine properly set up for a job and when once set up the job should be finished without interruption. There is another point worth considering. A workman does not care to shift his job, particularly when he sees that the shifting from one job to another is on account of bad management. When he sees the work before him has nearly run out, and he knows that there is more to come later on from the foundry or the smith shop in a short time, he will do everything in his power to make the job last until the remaining castings or forgings come in. In the shops under my supervision, before this part of poor management was corrected, by actual observations workmen decreased their output by one-half trying to drag out the job.

side machinist will bring some work from a ship to the shop and want it to be given right of way over everything else, as he has men waiting for it, or the shipfitter or shipwright or some other foreman will do the same. The "planner" gives this right of way as requested, but reports the case to the office and the urgency of the work is investigated. In nearly every case it is found to have been work that should have been foreseen and ordered some time before. The answer will be made to this that the other foreman or the outside machinist, to avoid such inquiries, will let his work and his men wait while the routine is followed. This tendency is admitted, but by proper supervision of the outside work this can be checked, or if it is not checked the remedy is a new outside foreman. This remedy I do not hesitate to apply if necessary.

SLOW SPEEDS AND FEEDS—LIGHT CUTS

(k) This is a fault common to the great majority of "day work" shops and is very common in Government shops. This is in a measure due to the lack of knowledge on the part of workmen and foremen of what can be accomplished with modern tool steels and the desire of the great majority of workmen to "take it easy." The paper read by F. W. Taylor before the Society of Mechanical Engineers on "The Art of Cutting Metals" treats of this subject in an exhaustive manner. It is probably the most valuable publication in existence on this subject. A copy of Mr. Taylor's paper should be in every machine shop. In the machine shop under my supervision one copy is kept in the planner's room for reference and the "speed boss" has another copy. The contents of the paper are frequently discussed with the supervisory force in the shop and in this way Mr. Taylor's teachings are impressed on the supervisory force. The speed boss is provided with a speed meter and he uses it. Each turning machine in the shop is provided with a diagram, Fig. 5, which gives the cutting speed for any position of the belt or notch on the controller, for various diameters of work. The workman knowing the diameter of the work can tell the approximate speed at which he is cutting. Tables showing the maximum speeds, feeds, and depths of cut for steel and cast iron are posted throughout the shop. This table gives information as to the results that *can* be obtained, and it is the duty of the speed boss to see that the maximum is obtained for the various classes of work. There is not much data available on this subject for planers, shapers and drills, and the speed boss has to use his judgment and force the machine until the tool will stand no more. Data is being collected regarding these machines and in the near future it is expected to post in the shop standard speeds for them.

LACK OF TOTE BOXES, ETC.

(l) Time is lost in not having proper facilities for handling small material about the shop. This is corrected by supplying convenient sized tote boxes. These boxes should be placed in a standard place at the machines which should be convenient to the operator and not require him to stoop to reach the piece. This is accomplished by placing low wooden tables alongside the machinist on which the boxes are placed. In small articles where the machine operation is short this detail is important and considerably increases the output.

LACK OF INFORMATION REGARDING MODERN PRACTICE

(m) The average navy-yard foremen, quartermen and leadingmen, and also many shop foremen in private shops do little technical reading. They are not well acquainted with the improvements that are constantly being made both in machines and methods. To remedy this, new books on these subjects are purchased and placed in the planning department for reference and issue to the supervisory force. These can be taken home by giving a receipt. Articles of special interest noted by the head of the department are marked to attract attention and are frequently discussed with the supervisory force. Any interesting or valuable information regarding shop methods or appliances obtained by the head of department by correspondence or by observation is sent to the shop in the form of a memorandum. A following article will show how these elements of inefficiency have been corrected in the machine shops of the construction and repair department at the Mare Island Navy Yard.

Cutting Racks with a Hob

In view of the revival of the process of cutting gear teeth with a hobbing cutter, the application of the same principle to rack cutting has special interest at this time. The illustrations are from patents granted Walter L. Cheney, Meriden, Conn., December 30, 1902, so that it will be seen the idea is not new and no startling originality is claimed for it.

The bed *A* carries the carriage *B* which is fed by the screw *C* in much the same way as the platen of a screw-driven planer. The rack *F* is held on the cross slide *D*, while the hobbing cutter *E* is driven, through bevel gears, from the same train of gears as the screw. The hob is set at the necessary angle the same as in cutting gears, and as the hob cuts the rack blank advances under it.

When the first cut is completed, the hob rises out of the work, the carriage *B* returns at a high speed as in a planer, the hob lowering into the work at the beginning of the cut after the rack has been fed toward the cutting teeth by the cross movement of the slide *D*, due to the ratchet-controlled screws shown under the cross slide. Should these fail to work, no harm is done, except loss of time in running without taking a cut.

The reversal is controlled by tappets the same as in a planer, and the operation of the whole machine has been worked out in a very practical manner.

Fig. 3 shows the action of the hob during different cuts, the last being completely across the face of the rack.

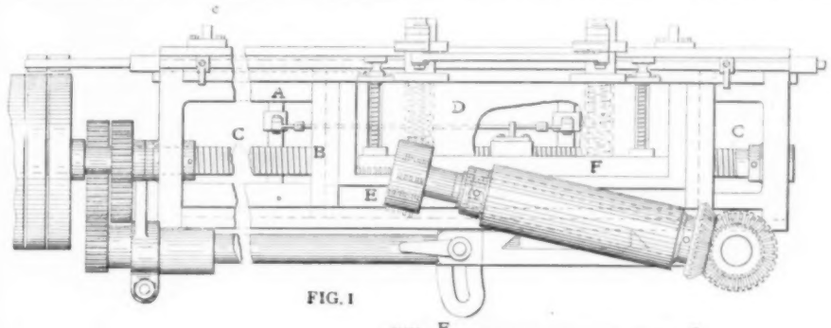


FIG. 1

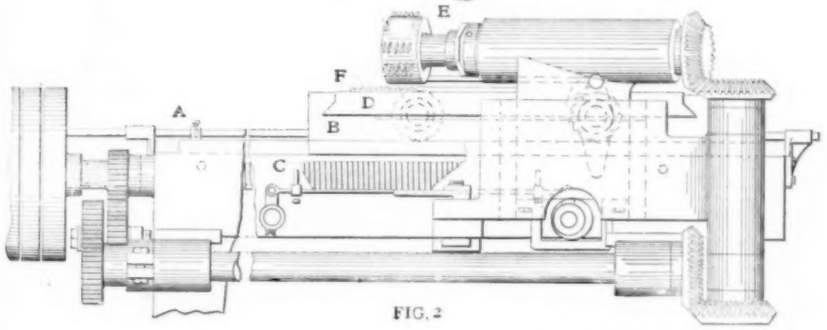


FIG. 2

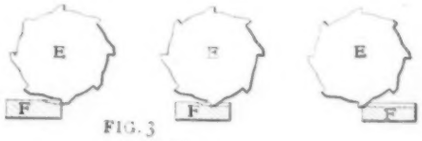


FIG. 3

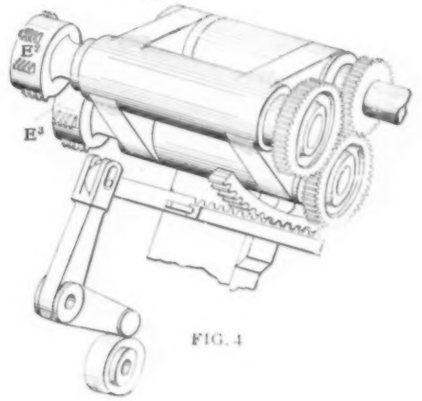


FIG. 4

CUTTING RACKS WITH A HOB

Fig. 4 shows a device to enable a cut to be taken in both directions, so as to avoid all loss of time. The two hobs are mounted in a frame and either the forward or return cutting hob is moved into position at the end of the stroke by the cam operating the segmental gear through the bell crank and rack.

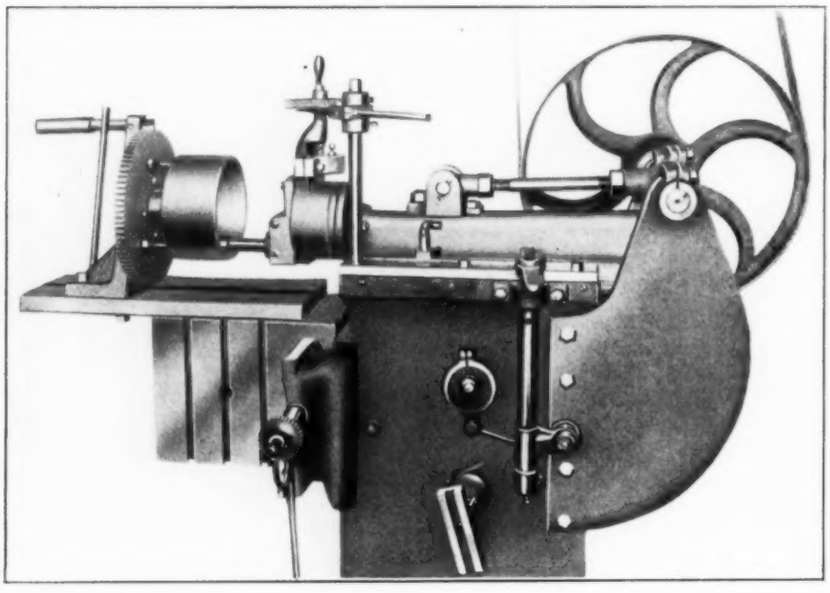
We regret not being able to show photographs of the machine on which these ideas were worked out, as Patent Office drawings are unsatisfactory in many ways; but the plan is especially interesting at this time.

Cutting Internal Gears and Making Clutch Fingers

EDITORIAL CORRESPONDENCE

Here is another device for planing the teeth of internal gears down next to a shoulder with only a clearance groove between for the tool to break through into. This was devised by my old shop mate, Frank E. Harthan, now superintendent of the McFarland Foundry and Machine Company, Trenton, N. J., to plane some gear boxes for motor-boat drives.

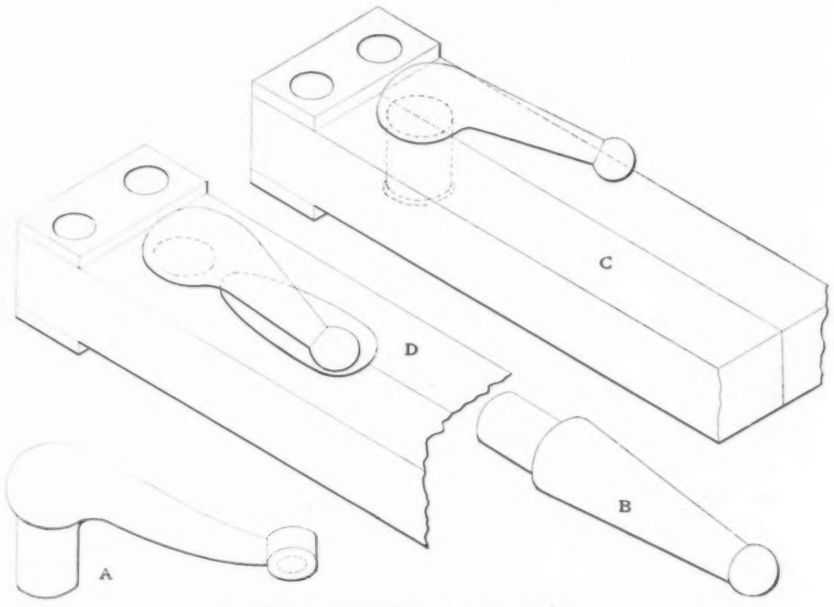
There was an old shaper that had long ago earned a place on the retired list and this was commandeered for the purpose, the driving mechanism changed to the positive, short throw crank on top of the ram. An angle plate was fastened to the table and on this an index plate was mounted, the indexing being held by a stop like a cutting-off knife, that holds it firmly.



CUTTING INTERNAL GEARS ON A SHAPER

On the same stud with the index plate, the outer gear blank is mounted, supported at the back by three studs to hold it against the cut. The tool is held in the cat-head tool post and the downward feed at every stroke is secured by the ratchet shown on top of the feed screw and fed down to a stop. Then the work is indexed, the tool fed up to the starting point and the operation repeated. It was only rigged up as a temporary device to try out the gear box, but does the work so well that it seems likely to be used for some time to come.

Another part of this gear box that is interesting as an unusual operation or method is the making of the clutch fingers. The clutches have a bent arm or finger for gripping the cone as shown in *A*, Fig. 2. As only a few were wanted at first it was very natural to rig up some device for making them before drop forgings could be thought of. So he turned the pieces up straight on a Jones & Lamson flat turret as in *B* and made a pair of bending clamps shown in *C* and *D*. These were about one-inch square stock fastened together at one end by the cross pieces and rivets shown. Near the pivot end a hole was drilled to fit the round shank of the piece *B*. The pins are heated, clamped between the two bars, hammered down with a heavy hammer as in *C*. The angle prevents the crack between the bars making a line along the piece as would happen if it was hammered down straight.



FIXTURE FOR BENDING CLUTCH FINGER

The next step is to turn the clamps over, put the piece in the other side up and force it down into the depression shown in *D* to get the right bend. Then the bolt on the end is flattened with a hammer to form the pad for the set screw.

This is a very primitive proceeding, the clamps being held by hand and the treatment of the finished work seeming decidedly out of place. So when the gear box was found to be such a success that orders began to come thick and fast, they looked around for a better method and very naturally thought of drop forgings as the proper caper.

So they proceeded to get estimates from several firms who make a specialty of this work. These estimates were so high that they are still making them in the old way and even though it is crude with a capital *C*, the cost is from one-half to two-thirds that of drop forgings even in good sized lots. All of which emphasizes the fact that what is good business for one shop may not be for another and that there are cases where hand work can still hold its own with more advanced methods.

F. H. C.

Gas-engine Shafts

By W. H. Booth

For a given power the shaft of a gas engine has a diameter considerably greater than that of a steam engine running at the same speed. Ordinary rules for steam-engine crank-shaft design are wholly unsuitable for determining the diameter of gas-engine shafts, as a little consideration will show. In four revolutions the steam engine has eight steam impulses; the four-cycle gas engine has only two. Each gas-engine impulse must, therefore, have a mean pressure four times greater. Neglecting for the moment any difference in initial pressure, this means that the gas-engine shaft must have four times the horizontal strength of the steam-engine shaft.

The torsional resistance of round shafts varies as the cube of the diameter. If, therefore, the shaft of a steam engine has a diameter of 6 inches, the diameter of a similar gas-engine shaft must be the cube root of four times the cube of six. Now six cubed equals 216, $216 \times 4 = 864$, and the cube root of 864 is just over 9½. Another consideration now comes into the calculation. In a steam engine there is always a variation in torsional stress from nothing to a maximum. The maximum stress occurs at that point in the stroke where the product of the mean pressure and of the actual crank length is a maximum. This point may be found by plotting the crank positions for several points in the indicator diagram and correcting for inertia effects Probably under most conditions it will be found to occur at such a crank angle as does not call for much correction for acceleration effect.

But this torsional stress in the ordinary double-acting engine is always in one direction, though variable in moment.

This is not the case with the gas engine, for owing to the driving back of the piston by the crank-pin against sometimes the inertia of the moving parts, at other times against this force and the pressure of compression, the torsional stress varies between a maximum in one direction and a maximum, smaller in value, in the other. Reversed stresses are approximately equal to a stress in one direction, which is the sum of the reversed stresses. If these be found and allowed for on a proper basis the new diameter of the shaft will be found to be about 10 inches. Thus in a rough, approximate manner it is found to be 67 per cent. greater than the shaft of a steam engine of equal power and speed.

To master thoroughly the subject it is necessary to look up something of what Wöhler laid down as variable and reversed stress effect in steel, and to determine from characteristic diagrams of steam and gas engines the effective moment of torsion. It was entirely to a neglect of this really simple matter that all the early high-speed engines were such lamentable failures. They were simple acting, and their designs made the crank-shaft twice the strength of double-acting engines. Thus a 6-inch shaft would have become $d = \sqrt[3]{6^3 \times 2} = 7\frac{1}{2}$ inches. A 3-inch shaft would have become 3¾ inches in diameter.

The driving back of the moving parts was neglected, so also was the air-compressing piston which was fitted to some single-acting engines to preserve a constant downward pressure. This air cylinder increased both the forward and the backward work on the crank and necessitated a shaft diameter still larger than the double strength apparently necessary. Calculations made in one case pointed to the necessity of six to seven times the strength as compared with a double-acting engine of equal power; that is to say, a diameter fully 75 per cent. greater. Such a figure was scouted as absurd and the struggling onward path of the single-acting steam engine was strewn with the twisted-off wreckage of hundreds of crank-shafts. Some good engines never fought their way to success. Their shaft failures ruined them. Slowly and reluctantly diameters were added to a quarter of an inch at a time and still the shafts failed. At length they grew to the dimensions that Wöhler's law indicates as right.

It is long enough since Wöhler propounded his laws, and longer still since Fairbairn and Hodgkinson had shown the same truths; but no one heeded. They preferred to prove over again on costly engine shafts what had been proved on simple test pieces. Fortunately for the gas engine its working fluid was so violent in action that it frightened designers into more liberal shaft diameters. The present large size of shafts is probably not so much required by reason of the heavy initial pressure of explosion as by the causes referred to above. The doubling of the cranks has been necessitated of the high initial pressure, for this produces severe bending stresses on the shaft. These are best provided for by a double support, the shaft being changed from a beam supported at one end by a beam supported at both ends.

Effect of Slowly Applied Loads

This brings up another point of great and vital interest in shaft design. A slowly applied load on a beam produces half the deflection that is produced by a load suddenly applied. In the first place the beam slowly deflects and the load reaches the point of maximum deflection without any vertical motion. A suddenly applied load falls vertically as the beam deflects and acquires energy; the total deflection is thereby doubled. If, however, the beam be pulled downward when unloaded by an amount equal to the deflection produced by the steady load, then the sudden application of the same load will produce no further deflection; for there will be no vertical falling due to gravity. All that will happen will be that the tension in the rigid pulling down rod will be relieved.

Now to put this into the argument of the crank-shaft let a shaft of mild yielding steel be made. The application of a torsional stress will twist it through a certain small angle. The movement of the crank, taking place before the body of the shaft is twisted far enough to resist the moment, is the counterpart of the deflection of the girder. It represents a load falling through space and the angle of torsion of a yielding shaft is made so much greater. The fiber stress of the steel is thus increased. Arguing from this parallel, some of us think that crank-shafts, especially for high-speed steam engines and gas engines should be made of high-tension steel; that mild ductile steel is not a proper material and that a crank-shaft should be stiff and rigid. This will reduce the "fall' or impact to a minimum. There is no true impact generated by the gas or steam pressure except so far as it sends forward a heavy projectile, the piston, and forces the crank-shaft to twist through an angle greater than the angle of working torsion.

These angles of twist are of course exceedingly small, even with the weakest shafts, but they have their effects. Rigid tough steel of high tension such as is known as gun steel makes better shafts than mild steel, for it does not yield to the same extent. Since the acquired velocity varies with the time of application of the load, and the energy of impact varies with the square of the velocity, it follows that the stress induced by yielding varies with the square of the angle of torsion. The tangents of these small angles are practically proportional to the angles. By doubling the rigidity of a steel the angle of torsion on applying a sudden pressure will be halved, and the stress due to impact will be quartered. Practical experience with small high-speed engines in Great Britain has demonstrated the soundness of this practice.

The use of soft ductile steel has proved excellent for steam boilers; but steam boilers are not exposed to stresses of impact. Their stresses arise from static pressure, from expansion and contraction and from localized heat effects. Where tension is set up a ductile steel seems to be safer, but even in boiler work a harder and more rigid steel is employed where compressive stresses come into play as in the furnaces of internally fired boilers. At one time there was perhaps more reason to distrust a hard and tough steel than there is today. Now they can be trusted if they are honestly made and are free from wrong ingredients; in particular free from phosphorus. There can be very little doubt but that most steel failures have arisen from an excess of this dangerous and pernicious element.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Making Cast-iron Gibs

We used to finish these gibs, of which we made quite a number, on the shaper, but had difficulty in keeping them to size. I therefore made the jigs shown to do the work on a milling machine.

We got out two jigs, the first one to hold three gibs at a time and thus mill three sides at once in one cut, getting them square and parallel at the same time. And the other jig was made to mill the angle on the fourth side, holding two gibs at once.

The first operation is to mill or shape one side flat; this operation takes five minutes. The second operation is done on the jig Fig. 1, which holds three gibs, a gang mill finishing three sides of the three gibs at once. These gibs are only 5/8 inch thick and about 1⅛ inches wide on the widest side and are held with two 5/16-inch set-screws, one on each end as centers. I drilled a 5/32-inch hole 3/16 inch deep 1/64 inch higher than the point of screws into each end of the gib so that they would pull down on the base when milling them. The drilling is done with a small drilling jig that fits on each end of the cast-iron gib after the one side is roughed.

The first time these cutters were put in the machine and before I used them everything looked good with cutters and jigs in place and the gibs in their places, but when I began to cut, out came the gibs. I found that having the cutters running against the feed would pull the gibs up from the base and break them. I then set the feed in the same direction as the cutters and this made a good job after tightening the gib screws in the table so that the table worked hard. This can also be done with a counterbalance weight for the table to take up the slack of the nut on the screw.

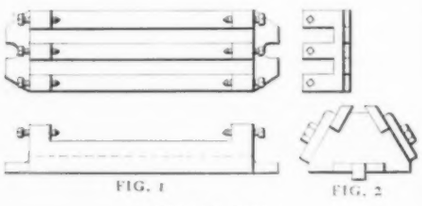


FIG. 1 FIG. 2

MILLING GIBS

To finish a gib in this way takes just 12 minutes with the cutters running 30 ft with a feed of 0.052 per revolution of cutters, setting time included. When these three sides were done I then put in the jig shown in Fig. 2, to mill the angular edge of the gib. This jig needs no explanation; it handles two gibs at a time. When this operation was done I used a vise to mill the two ends. I used two large cutters and did the two ends at one time, holding 10 gibs at one setting, in two minutes each.

The job took two hours and 10 minutes on the shaper and only 36 minutes on the milling machine.

Newark, N. J. A. EHRHARDT.

The Inverted-V versus the Flat-bed Lathe

I have read with much interest the articles which have recently appeared in the columns of the AMERICAN MACHINIST regarding the different methods of grinding the carriage and tailstock of engine lathes. I have designed and worked on lathes of various sizes and, while in my opinion the inverted V-type is superior to the English type of flat-top frame, and is perhaps very satisfactory for a lathe used for toolmaking, or other light work, I think there is a chance for improvement on machines designed for heavy duty.

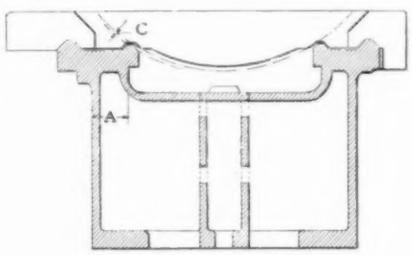


FIG. 1. THE INVERTED V BED

F. J. B. in his article, at page 105, refers to the wear on the V's as being directly downward, while Professor Sweet in his article, at page 173, considers the pressure heavier on one side than the other, but says that the wear of the V's in boring is deducted from the wear due to turning. I cannot agree with them on this point. There is no doubt that the pressure is greater on one side than on the other, but boring is a rather delicate operation when compared with external turning, and in the modern shop usually constitutes a small portion of the work done in a lathe. It is usually performed near the face-plate and in a machine of average length the wear would be uneven at any rate. I have worked on various makes and sizes of lathes of the V-pattern, some old and some new, some that should have been in the scrap pile, according to my judgment, and I do not recall many instances in which an old lathe would turn straight for any great length, the tool being on the center. Some, in fact, I imagine would turn about like the English lathe referred to by Professor Sweet if left to themselves. A short time ago I visited a shop where the firm where I am employed had installed a special lathe and the foreman called my attention to the condition of the V's on the lathe they had previously used for the job. The sides of the V's receiving the external pressure were worn, leaving a shoulder of over 1/64 inch, while the opposite side showed but slight wear. It is customary in some shops to set the tool considerably above the center. I recently visited a shop to note the operation of a new lathe which I found working on 14-inch shafting with the tool 2½ inches above the center which, without considering any pressure at right angles would give 21 degrees as the angle of the cutting force from vertical, from which it is evident that a large percentage of the pressure would come on one side of the V's.

The carriage on the inverted V-type of frame has been referred to as never skewing. This I think would be impossible as the wear on the V's is not uniform, consequently the carriage could not fit in all positions unless it was recessed in the center, which is not usually done, as this is the point of application of the cutting force. The force which moves the carriage is usually applied some distance from the line of the tool, and when a taper attachment is used there is resistance still farther from the point of application, altogether causing a tendency to skew, thus increasing the wear at the ends of the carriage. Skewing is no doubt most objectionable when cutting threads.

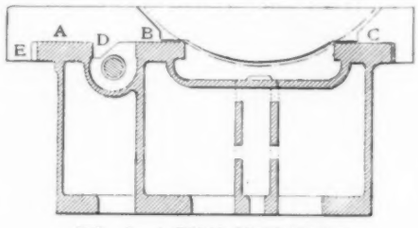


FIG. 2. A FORM OF FLAT BED

Regarding the V's for guiding the tailstock, this method is probably as good as any, the only objection being that they reduce the thickness of the carriage. The full swing is not changed much by remov-

ing the inside V's as will be seen at *C*, Fig. 1. So it is evident that, keeping the swing over the carriage the same in each case, which is important, a frame without V's will allow for increasing the thickness of the carriage an amount almost equal to the hight of the removed V's. A flat bearing at this point affords an opportunity to give the carriage a bearing the width of the bridge. This greatly increases the rigidity of a lathe especially where the frame is not strongly reinforced at *A*, Fig. 1, which is often the case, and works very well when the proper wipers are provided and the operator gives them a little attention. F. J. B. speaks of this method of guiding the tailstock as being poor. I have used it successfully by providing a taper gib, the vertical bearings being recessed in the center to avoid rock.

I have seen no mention of the American type of flat-top frame as is seen on some of the heavier lathes used for gun work, etc. Fig. 2 gives a general idea of one that recently came to my notice. The bearings for the vertical forces are at *A B C* and the guiding is done at *D E*. This gives a guiding surface in which the ratio of the length to the width is very high, the value of which has been pointed out by Professor Sweet at different times. I have held that this is the proper method of guiding a lathe carriage for some time, although the design of frame shown in Fig. 2 would not be very suitable for the smaller sizes of lathes. When using this method of guiding the bearing *D* can be recessed in the center without decreasing the rigidity of the carriage, and *E* provided with a taper jib at each end which will eliminate the skew so long as the guiding surfaces of the frame remain parallel which, of course, they will not do for any great length of time, but if properly guarded and provided with wipers the wear will be very slow and I think the skew will be less than with the V-type.

For a fair example of this we have only to consider some of the heavier types of boring mills, the saddles of which are guided in this manner and give good results. Here the saddle is usually short as compared with a lathe carriage, and the cutting force instead of being over the bearings is always outside. The only advantage is the absence of chips from the bearings; but there is always more or less dust in the air when working cast iron, and as only the smaller particles could work into the bearings in the case of a lathe I can not see much advantage in this respect.

Syracuse, N. Y. R. THOMPSON.

The letter of F. J. B. on page 105 on the above subject is pertinent. I am largely in agreement with him in his remarks on English lathes if applied to lathes made up to the last few years. However, as he is in Canada it is possible he may not, as yet, have handled examples of some of the latest English pattern lathes. In the type first brought into prominence by John Lang & Sons, of Johnstone, Scotland, the guiding of the saddle is performed by the front shear only of the lathe bed, and the relative proportions of the length of guide to its width is thus considerably increased, and the actual length of saddle has in some British instances been increased also, while long taper gibs make the taking up of slack an easy matter. Beds in which the shears are protected by guards from the ill effects of chips and dirt are also not unknown, and the harder metal generally used in British practice insures that a lathe well made in the first instance will be accurate for all practical purposes quite as long as is commercially advisable to retain it in commission, and I should think it is an easier matter to true up an English type bed and saddle, if needed, than is the case with the American. Again, if, as is stated, the weight of the saddle and the downward pressure or the cut is so great that the saddle cannot lift from the V-ways, why are weighted saddles offered as an advantage on certain high-class toolmakers' lathes? Then, also, the tailstocks are now generally made so that the tongue fitting in the interior parallel way of the bed is drawn against the inner edge of the rear shear when the tailstock bolt or bolts are tightened. I can feelingly indorse F. J. B.'s remarks in this connection. As a youth I worked on lathes in the manipulation of which a short-handled sledge hammer had to be used—when taking trial cuts to obtain parallelism—to knock the tailstock in or out as required. It may be that the average American lathe is more accurate than the average English lathe, but it would be almost impossible to appraise the exact commercial value of any superiority that exists, or existed, as lathes are required for such a large range of duties that an inaccuracy on one particular job which would be a serious matter to one user, scarcely affects another if the lathe is easily manipulated and powerful and strong enough for the particular duty. I think it will generally be admitted that British lathes have in the past been characterized by greater power, and durability of members than the American types, and this fact at once told in their favor on the advent of high-speed steel, as existing British lathes were better adapted for immediately utilizing it to considerable advantage, and in most cases durability then began to count quite as much as handiness. The cone-bearing spindles on up to say 24-inch swing lathes are a capital feature when thoroughly well made for a start and afterward used and adjusted by competent men. Better all-around results are, however, generally obtained from the use of hollow parallel-bearing spindles, which, I might add are now almost as common on British as on American lathes, with the further advantage that, as the old solid spindles were usually at least as large in diameter as the American hollow ones, the increased diameter now accorded adds still further to their durability and relative freedom from chatter.

I cordially agree with F. C. B. that the British method of raising the number of teeth in change gears by fives is more convenient than the American system, and the coarse pitch-lead screws are not only convenient, but allow of a much wider range of threads being cut than in the American practice. I have often thought on seeing the specification of the threads which American lathes are designed to cut, that the coarsest mentioned is just about where many British users think of beginning when they are considering the lathe in its capacity as a screw-cutting one. They will think nothing of a lathe of 16 inches swing cutting a worm thread of 3½ to 4 inches lead. Personally, if confined to the use of one lathe, I would prefer one without the nest of gears for instantly obtaining any one of a lot of *fine* pitches, my choice being one in which could be cut almost *any* thread. If a number of threads were in constant shop use, such as gas threads, a nest of gears could be provided for these threads, at the same time retaining full flexibility of pitch range by the usual means.

I am at one with our Canadian friend in his opinion on compound rests, especially in his remarks on the method of holding the tools. As he mentions, it is not necessary to use bent tools when working close to the chuck; and the tool angles are preserved. The range of shapes and varieties of tools which can be held is also much greater in the English than in the American types. I have seen boring tools, held by two straps and four bolts, projecting three or four feet from the rest and doing decent work. I am afraid no American lathe would do this. Of course, few Americans would think of doing this, but I have known occasions on which it paid very well indeed.

I do not wish to dispute the statement that the inverted V-type of bed is the more accurate, if well carried out, but it appears to me a more difficult or expensive (which is pretty much the same thing) form to originate and my impression is that it was never deliberately adopted by American tool designers in general, but, as a survival of old English practice, was found in use by them, and perpetuated because such action followed the line of least resistance, just as English makers, after the use of planing machines became general found it most easy to make the flat-shear type of bed, and therefore adopted it. Previously, inverted gray iron V's were often fastened on to wood shears.

In these remarks I have no wish to belittle American lathes, as British builders have, during the last number of years, been indebted to their special features for many wrinkles they have now embodied in

their own designs. I have simply endeavored to follow F. J. B.'s example of fair treatment of the subject. By the way, Professor Nicholson, now identified with the Manchester, England, School of Technology, was formerly in a responsible position at McGill University, a Canadian Institution. I have been rather surprised at the lack of response on the part of American tool builders, to the editorial invitation to give reasons for their non-agreement with views advanced by Professor Nicholson. JAMES VOSE.

Manchester, England.

I have read with considerable interest this discussion. I know both types well, as I served my apprenticeship in Scotland in a shop where there were approximately a hundred of the flat-bed monstrosities. I never saw a flat-bed lathe that would turn even approximately straight.

When I started for myself I bought an old-style Hendey lathe; it was one of the last they made. This lathe was used for all kinds of work. It was originally 16-inch swing, but I made blocking for it so that I could swing 25 inches. For nearly ten years this lathe was used for all classes of work and by all kinds of men. Sometimes the raising blocks were in and sometimes they were not, the lathe had every chance to wear out of true, but when it was nearly ten years old I bored two cylinders, with a single-toothed boring tool, which proved that that particular lathe had not gone so very far wrong. The cylinders were six inches diameter by 18 inches long. They were bolted to the face plate. The boring bar was made of 1 15/16-inch cold-rolled and had a cutter inserted in the end. The bar was fastened to the carriage. The cylinders were bored within 0.002 parallel and one was 0.002 larger than the other. This, after nine years of hard and sometimes rough work. I have never seen a flat-bed lathe that would do as well when it was new. E. A. DIXIE.

New York.

Tests of Square Springs

A few square springs had been purchased for cylinder-relief valves; before placing them in the valves they were tested for deflection, so as to determine the distance between the coils when in working condition. The test showed that the distance between the coils was too small to permit of sufficient working lift; therefore the springs were condemned.

The size of the square wire had been calculated from Begtrup's formula, which was published in the AMERICAN MACHINIST in 1892 and is given in Kent's "Hand-book." The excessive compression of the springs caused an examination of the calculations, which were found to be correct, and finally an examination of the springs. Instead of having a square cross-section as had been ordered, they were trapezoidal; to which fact was attributed their action. The cross-section of the new springs received from the manufacturer, after we had returned the old ones was square, and a test of the springs showed a deflection very near that which had been calculated. This proved the practical correctness of Begtrup's formula.

SPRING No. 1.	3½" Outside Dia.	Load.	600 lb.	720 lb.	900 lb.			
	7/16" Square Wire.	Deflection.	2 5/16"	2 5/8"	2 15/16"			
	9 Free Coils.	Values of *E*.	8,640,000	9,125,000	10,200,000			
SPRING No. 2.	3 7/8" Outside Dia.	Load.	300 lb.	600 lb.	720 lb.			
	7/16" Square Wire.	Deflection.	1/16"	1 1/8"	1 15/16"			
	7 Free Coils.	Values of *E*.	13,500,000	13,500,000	13,570,000			
SPRING No. 3.	2 15/16" Outside Dia.	Load.	450 lb.	780 lb.	900 lb.	1200 lb.		
	7/16" Square Wire.	Deflection.	5/16"	15/16"	1 5/16"	1 15/16"		
	8 Free Coils.	Values of *E*.	12,100,000	14,000,000	11,500,000	12,900,000		
SPRING No. 4.	1½" Outside Dia.	Load.	75 lb.	120 lb.	150 lb.	210 lb.	240 lb.	270 lb.
	5/32" Square Wire.	Deflection.	5/16"	7/16"	1/2"	5/8"	23/32"	25/32"
	8 Free Coils.	Values of *E*.	8,375,000	9,600,000	10,480,000	11,750,000	11,650,000	12,050,000
SPRING No. 5.	2½" Outside Dia.	Load.	300 lb.	450 lb.	525 lb.	600 lb.	720 lb.	900 lb.
	7/16" Square Wire.	Deflection.	1/4"	5/16"	11/32"	13/32"	1/2"	11/16"
	8 Free Coils.	Values of *E*.	10,800,000	12,950,000	13,790,000	13,500,000	12,990,000	11,810,000
SPRING No. 6.	2 1/16" Outside Dia.	Load.	150 lb.	225 lb.	300 lb.	375 lb.	450 lb.	600 lb.
	1/4" Square Wire.	Deflection.	1/4"	5/16"	7/16"	9/16"	11/16"	1"
	4 Free Coils.	Values of *E*.	17,250,000	20,700,000	19,700,000	19,000,000	18,750,000	17,208,000

TABLE I. LOG OF TESTS ON SQUARE WIRE SPRINGS.

Begtrup's formula for square springs is:

$$F = \frac{4.712\ P\ (D - d)^3}{E\ d^4},$$

where F = the deflection per coil in inches,
P = the load on the springs in pounds,
D = the outside diameter of the springs in inches,
d = the diameter of the wire in inches, and
E = the torsional modulus of elasticity.

In the second half of the equation all the parts are known, due to the design, except E; therefore E has to be assumed. Kent's "Hand-book" gives values of E varying from 10 to 14 millions. In order to obtain as nearly a correct value of E as possible for ordinary spring steel, a test under different loads was made of the second lot of springs received. The deflection was measured for each load from which E was calculated. These values have been tabulated and are given in the table, Fig. 1.

For spring No. 1 the values of E varied from 8,640,000 to 10,020,000; spring No. 2, about 13,500,000; spring No. 3, from 11,500,000 to 14,000,000; spring No. 4, from 8,375,000 to 12,050,000; spring No. 5, from 10,800,000 to 13,790,000; spring No. 6, from 17,200,000 to 20,700,000. Springs Nos. 1 and 4 seem to have about the same values; Nos. 3 and 5 about the same values; No. 2 was nearly constant, while No. 6 was very high. The material of all the springs was supposed to be the same.

After carefully examining the values of E obtained from this test, it was decided to use 11,000,000 in all future calculations. This was subsequently tried, by testing other springs, and found to give values for deflection per coil within 0.02 inch of that calculated, which is near enough for practical purposes. O. JAMES.

Pawtucket, R. I.

Bench Centers — Cutting V-Threads

"Entropy's" letter on page 324, interested me in two or three respects.

He suggests that we at the Artisan school attach our bench centers to a straightening press. I never thought of it, and I am glad I did not. A straightening press would have been too much for us and that might have discouraged me.

I am glad to know that he used the spring center long ago. After designing the machine, in fact after its publication, I discovered that B. & S. had the same trick in their machine, and I trembled in my shoes for fear they would charge me with piracy; but I have no fears of Entropy, now he appears to be out of the business, though as I introduced that in the Cornell grinding machine over thirty years ago and described and illustrated it in the *American Artisan* maybe that antedates the lot.

As to asking a high price or a low one: It's a question between twenty-five dollars or a hundred. Will there be more people who will pay one hundred dollars for a hundred-dollar machine, than there are who will take the one hundred-dollar machine at twenty-five?

Entropy questions the possibility of cutting an equally spaced double thread on a lathe feeding in the tool at an angle.

I cannot see any interference with two

opposite slots for the tail of the dog in the face plate, the thread ought to come right. The cross slide must be run out and into a fixed stop to use the system anyway, and with that I see no snag.

As to magnifying the indicating: I had thought of that, and doubted its justifying the extra expense, but as I have now devised a way to save one piece and multiply the reading by three, may adopt it.

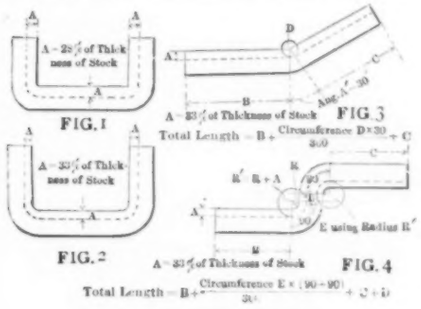
Syracuse, N. Y. JOHN E. SWEET.

Bending Sheet Metal

To the draftsman or machinist working on small machinery, such as adding machines or typewriters, there occurs very often the problem of figuring out the developed or straight length of a bent piece of sheet metal. The usual way a machinist deals with this matter is to form up a piece to size and then flatten it out. This apparently gives the developed length, but not actually so, as the metal invariably stretches when it is straightened.

After a long period of observation and experiment in this class of work, I have compiled some figures which will no doubt be of use to anyone who handles bent stock to any extent. When using these formulas, however, it should be borne in mind that any figures on this subject are necessarily approximate, as metals of the same grade and thickness will often vary slightly in the bending. This is due among other reasons to varying amounts of carbon in the metal and to irregular annealing.

When a sharp bend is made, as in Fig. 1, the metal stretches more than when there is a radius in the corner of bending, Fig. 2; therefore less extra stock has to be allowed in the former case. In computing the length of the stock an imaginary line has to be drawn along the edge of the metal, as shown in Figs. 1 to 4. This line varies in position according to the character of the bend. The quantity *A* in Figs. 1 and 2 shows the difference of allowance in making a sharp and a rounded bend. The other figures are appended in order further to convey the idea to the mind of the reader.


A = 2/3 of Thickness of Stock
FIG. 1
A = 33/100 of Thickness of Stock
FIG. 3
Total Length = B + Circumference D×30/360 + C
A = 33/100 of Thickness of Stock
FIG. 2
A = 33/100 of Thickness of Stock
FIG. 4
Total Length = B + Circumference E × (90 + 90)/360 + C + D

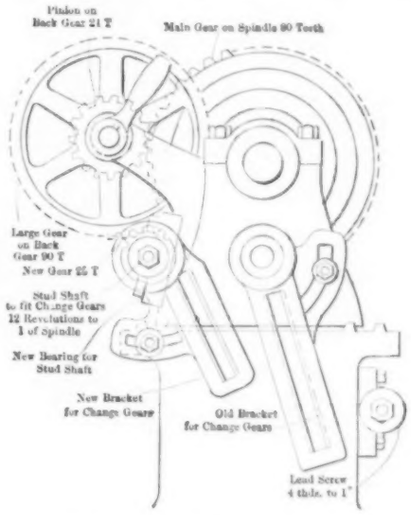
BENDING SHEET METALS

I would be very glad to read in the AMERICAN MACHINIST of the experience of others along this line.

Detroit, Mich. CHARLES F. HOWSE.

Cutting Steep Pitch Worms on an Engine Lathe

Having occasion for cutting some steep pitch worms of various leads and having a heavy 18-inch lathe idle, it was decided to equip this lathe for the work. The most feasible scheme seemed to be to increase the speed of the change gears by driving them directly from the small gear on the cone pulley of the lathe in place of the usual small gear on the spindle, thus giving ample driving power and utilizing the regular change gears. This was accomplished by the device shown in the sketch.


Pinion on Back Gear 24 T
Main Gear on Spindle 80 Teeth
Large Gear on Back Gear 90 T
New Gear 25 T
Stud Shaft to fit Change Gears 12 Revolutions to 1 of Spindle
New Bearing for Stud Shaft
New Bracket for Change Gears
Old Bracket for Change Gears
Lead Screw 4 thds. to 1"

CUTTING STEEP PITCH WORMS

Lead of Worm, Inches.	Stud.	Compound.	Screw.
1	24	none.	72
1⅛	36	none.	72
1¼	60	48/24	72
1⅜	66	48/24	72
1½	60	none.	120
1⅝	84	48/24	72
2	48	none.	72
2¼	72	none.	96
2½	60	none.	72
2¾	66	none.	72
3	48	none.	48
3½	84	none.	72
4	96	none.	72
4½	108	none.	72
5	120	none.	72
5½	66	24/48	72
6	120	none.	60

It consists essentially of a new stud shaft mounted in a bearing secured to the rear of the headstock in such a manner that a new gear, made with the proper number of teeth and secured to the inner end of the stud shaft, would, when the back gear was thrown in, mesh properly with the large gear on it. The other end of the stud shaft was made to fit the regular change gears of the lathe. The main gear on the latter spindle was found to have 80 teeth, while the pinion on the back gear had 24 teeth and the large gear on the back gear 90 teeth, so that the new stud-shaft gear was made with 25 teeth, causing it to make 12 revolutions to one of the spindle. The lead screw of the lathe had four threads to one inch; with these data the accompanying table was computed:

It was necessary to use three intermediate gears to reach over to the new stud shaft when a right-hand thread was to be cut, or two for a left-hand. The stud shaft was made long enough to use a compound gear if necessary.

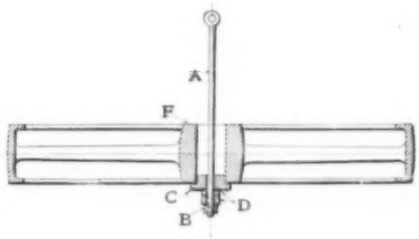
In laying out the work it was found advisable to add an additional bracket to accommodate the extra intermediate gears. On the whole the device proved very satisfactory and accomplished all that was hoped for it.

Cleveland, O. W. L. K.

A Simple Balancing Rig

The article by Wm. E. Snow, at page 8 reminds me of a balancing job that was done recently in a somewhat similar manner. Once seen, it is so obvious that it must be well known to mechanics. However, I had never seen it done before and do not recall having seen it described in the AMERICAN MACHINIST.

A new power plant was being installed and the old line shaft had been extended to carry a pulley onto which the new engine was to be belted. The pulley was 11 feet in diameter by 2 feet face, and was to run at 150 revolutions per minute. After it had been placed upon the shaft it was found to be out of balance and was taken down to await the arrival of a man whom the makers sent to balance it. The sketch shows all the paraphernalia that was used: The eye-bolt *A* threaded on the end for the nut *B*, the casting *C* from the scrap heap approximately fitting the bore of pulley and two spherically fitting collars *D D*. The pulley was laid flat upon two timbers on the floor, the eyebolt and collars were assembled as shown and the whole was raised by a chain block until it hung clear.



A SIMPLE BALANCING RIG

Of course the light side hung high and the balancing was proceeded with by attaching trial weights to the high side and noting results with a level laid upon the rim. The level was applied at four equidistant points and when it showed level at all these points the pulley was balanced. The permanent weights were then made from 1½x3-inch machinery steel bar, bolted to the inside of pulley and the whole retested. It required 57½ pounds

to balance. No fine results were attained nor aimed at as by Mr. Snow's method, but the method was similar.

I think that the method would be improved by substituting for the eyebolts a rope or steel cable centered in the bore of pulley at the upper end *F* of the hub by a bushing which could be of wood and quickly made. The end of the rope or cable could be secured on the under side by a loop around a piece of timber. This would eliminate friction and give more accurate results, although no doubt those obtained were sufficiently accurate for the requirements.

Waterville, Conn. RAYMOND GRANT.

The Old Shop and the New

A new shop just beginning business is, I believe, a more difficult place to work than an old out-of-date joint when it comes to having things to work with. The new shop has all the latest up-to-date machines of all kinds to produce great amounts of parts at only high-speed time. But until these machines get their tools and fittings, there must be something done. While waiting for the car load of high-speed steel to come and then be forged to shape, a great deal of work can be turned out with tool-holder tools.

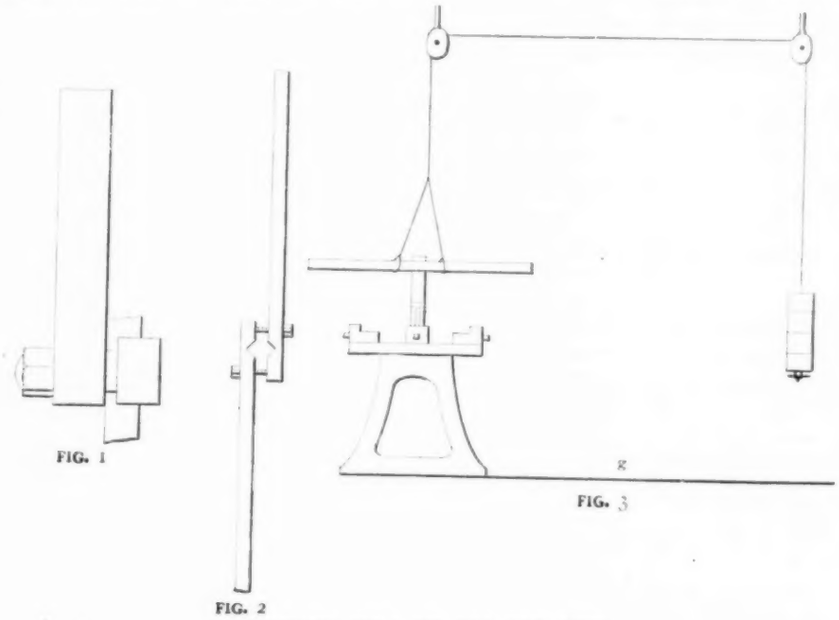
In the new shop it was hard to find bolts and clamps or washers or blocks of wood to set up a job on the planers or boring mill, to say nothing of parallel strips, angle plates, rod gages, and standards for close work. The shop in mind was to build heavy machine tools; the old shop might be any small repair shop.

In the old joint you can generally find enough stuff on the junk pile to take a job through somehow, and then there is a large difference in what is expected of a man in the two shops.

In the new shop, when planing a 35,000-pound casting, I found out just in time that the 1¼x1-inch cutter in a tool holder like Fig. 1 will work down into the cut deeper when on a heavy cut, although it be tightened with a 16-inch wrench and a hammer. Fig. 2 shows how a reamer wrench can be quickly made at a small cost by simply making two V-notches in some square stock and putting in several screws; this arrangement not only is an adjustable wrench, but secures a reamer from falling.

Fig. 3 shows an arrangement devised and used by an expert reamer hand, who was kept busy at reaming bored work and knew how the plug must fit and how to set his reamers. A three-jawed chuck on a stand, two pulleys on the ceiling leading the rope out of the way, and enough weights to balance the reamer saved time picking it up and the chance of its being changed when falling.

Ludlow, Ky. NOUMAC.

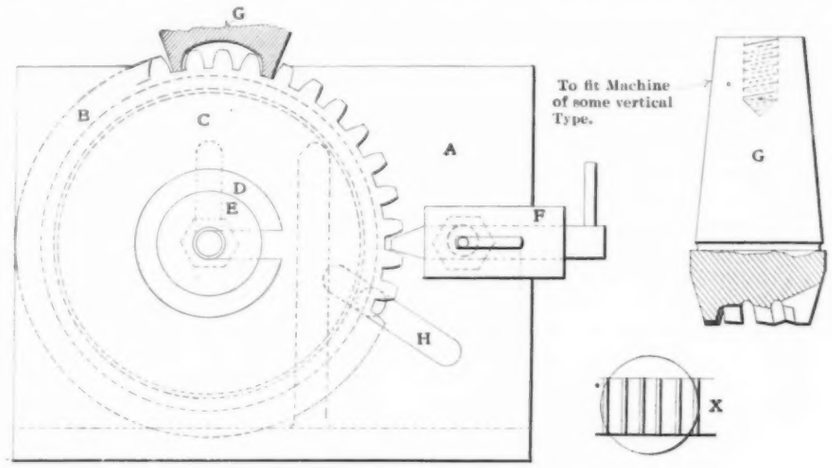


IMPROVISED TOOLS FOR THE NEW SHOP

Rounding Ends of Gear Teeth

The sketch shown herewith shows a method of rounding the ends of gear teeth for use in automobile transmission, although the same thing is equally good in any case of sliding gears in machine-tool gear boxes.

The angle plate *A* is put on the table of a vertical milling machine so that the gear is on edge and centrally located under the milling-machine spindle. The milling cutter is shown at *G*, from which it will be seen that it is practically a hollow mill with specially shaped teeth of the proper size to go over three teeth and mill the outer corners of the outside teeth, as shown at *X*. The teeth of the milling cutter are easily relieved on a Hendey-Norton lathe.



DEVICE FOR ROUNDING ENDS OF GEAR TEETH

The pin *F* allows the gear to act as its own index, and all that is necessary is for a boy to run the milling cutter down to a stop, return the cutter, move the gear one tooth and repeat this operation until he has been around the gear once, as each operation completes one tooth.

The usual arrangements are made for handling these gears quickly on the plate, such as the slip washer *D*. A boy will round the corners on an 80-tooth gear in 20 minutes. The slot *H* is for holding the index pin on different-sized gears.

St. Louis, Mo. JOS. F. WELLS.

Straightening Tracings

We have hundreds of tracings that have been used for reference, and are badly curled and some are worn, as they have been collecting for years. Some drawers contain between 400 and 500 each.

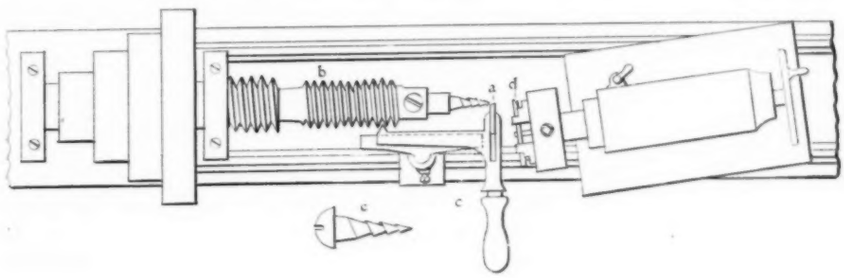
We intend to try and straighten them and put a less number in one drawer and would like suggestions from your readers, on the best method of ironing, or getting them flat. Most of them are 22x34½ inches in size. D. T. FLETCHER.

Cleveland, O.

Making Silver Bone Screws

We had a hundred silver bone screws to make like *e*.

We fitted the spindle *b* to the head spindle and cut the thread and bored it for ¼-inch silver rod. The taper was cut with a tool *d* held in a three-jawed chuck, so that the body of the chuck acted as a depth gage. The chuck was fastened in the tailstock, which was



MAKING SILVER BONE SCREWS

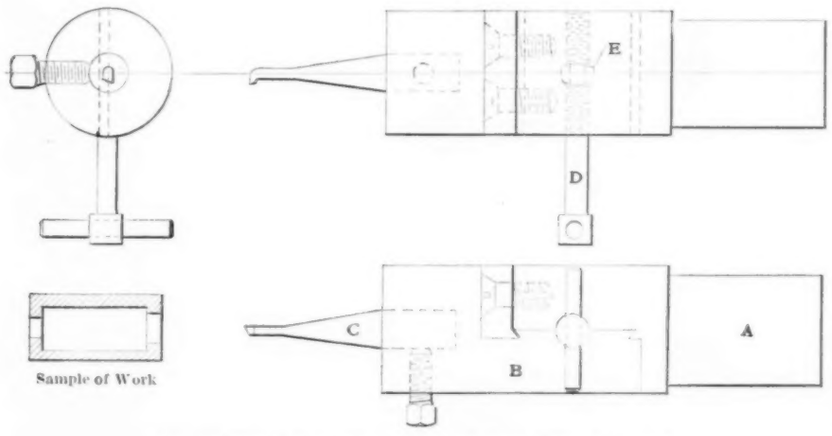
blocked up and swiveled to the proper angle to cut the taper. The thread tool *c* was forged and the cutter soldered into a slot milled for it. This tool was slid along the tool rest, the master thread *b* taking care of the thread on the work.

A boy, after cutting a few in brass, had no trouble in turning the silver screws.

Chicago, Ill. GEORGE SANDS.

An Adjustable Boring Tool for the Turret Lathe

The tool consists of a stem *A* fitting the turret and a piece *B* dovetailed to *A*, so that it can be moved across *A* by



AN ADJUSTABLE BORING TOOL FOR THE TURRET LATHE

means of the screw *D*. The part *B* forms a half nut for the screw *D*, and a half bearing *E* prevents the screw from moving on *A*. A small boring tool *C* of suitable shape is held in *B* by a set-screw.

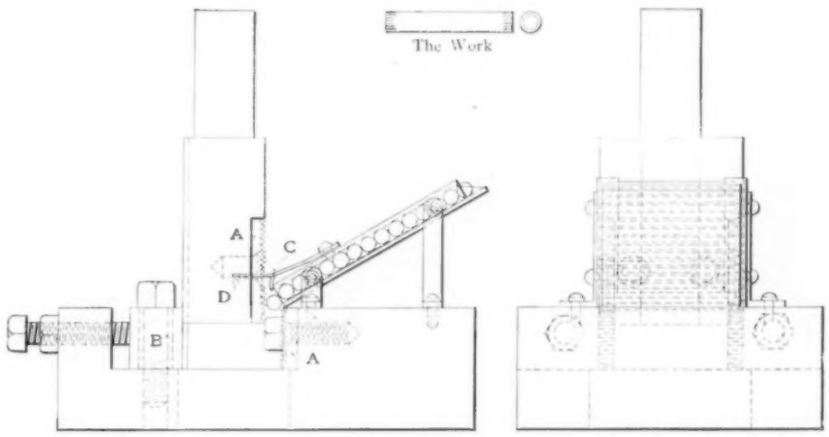
The tool is specially useful in boring out recessed work, of which a sample is shown.

Chester, Penn. W. ALTON.

Nurling on the Punch Press

We had a number of pieces, shown in the illustration, to nurl. Formerly we did the job in the lathe but we now do it on a punch press with the tools shown in the illustration. *A* are two pieces of steel hardened; the lower piece is stationary while the upper piece reciprocates with the press ram. The piece *B* having an oval hole permits the adjusting of the device for various sizes of work. The spring *C* holds the work in the magazine till the press ram comes up and the pin *D* on the ram lifts the spring *C* allowing the bottom piece to roll into contact with the nurling dies. One pass through is sufficient to make a nice sharp job, better by far than we got on the lathe.

Lockport, N. Y. C. R. G.



NURLING ON THE PUNCH PRESS

Why Does a Drill Cut?

On page 405 the above question is asked. It is not the purpose to state in this article why a drill will cut material of equal hardness, as I must confess my inability to make any kind of a drill work under such conditions. The drill in question being of high-speed steel, it is not uncommon to be able to file it after hardening.

Now it seems that some heat is an advantage in the use of high-speed steel as some steel at high temperature seems harder than when cold. With such conditions it would be reasonable to expect the soft drill to do some hard work. The drills no doubt were cold when starting the first hole, but it takes very little time for the abrasion of the point to warm up the drill, and as the point only is in contact when starting a hole, only that part of the drill would require heat to bring up the hardness and the heat could radiate to the circumference as the drill advances.

In a recent issue of the AMERICAN MACHINIST, data were published showing that a cutting tool had to be considerably harder than the metal to be cut.

This has also been my experience, as I have had a wide range of work which required extremely hard tools.

I venture no one would doubt as to the severe test of a tool that had to cut chilled iron which could barely be touched with a file. I may say that I have used tools for grooving chilled flour-mill rolls having 32 teeth to the inch. The depth of the teeth was about one-half the pitch. This is a very severe test for a tool which must be extremely hard. For tools on this

work Crescent double special steel A1 temper, or Firth-Sterling extra special steel gives good results. I have tried lower-carbon steels on this work, but the softer tools simply had the teeth pushed away, or in other words, the work cut the tool. With the best steels a deeper cut than 1/64 inch is impossible on the hardest rolls.

In this connection I may also state that the machine tool for such work must be very rigid to hold the tool into the cut with absolutely no spring or vibration whatever. The speed on such work cannot be over 30 inches a minute.

To get back to the question of durability of high-speed tools, the high speed causes a bit of metal to fasten or weld on the edge of the tool. This bit of metal gives the tool a cutting edge independent of its own, and probably increases its life. This bit of metal also forms on carbon tools at rather high speeds. The hardest part of the work is not the actual parting of the metal, but turning up the chip over the tool point.

Scottdale, Penn. M. B. STAUFFER.

In the editorial columns you ask for the opinion of some of your readers as to "Why does a drill cut?" I offer you the following solution based on some years of experience with cutting tools.

I have found that all tools subjected to the twisting action of the drilling tool cannot be as hard as cutting tools for other operations on the same kind of metal; I think this is due to the extreme cutting edge "falling down," and, as is well known, when a cutting edge begins to fail the load on the tool is increased. This causes more of the edge to fail, and the result is, the tool soon refuses to cut. This condition is very much aggravated in drilling, as the minute particles of metal that break off from the cutting edge fall on the metal being drilled; some of them are forced into the work by the drill, and as they pass under the cutting edge they "grind" off the cutting edge of the drill in much the same manner as would be the case if the work was filled with small particles of emery.

The point of a drill is always a hard thing to keep in a proper cutting condition, and in many cases the destruction of the cutting edge begins at the point, in the manner I have indicated. In the cases you mention the outer edge of the lip seems to have failed first; this would cause the drill to wedge in the work, thus increasing the load on the drill, which in turn would cause more of the lip to fail. In other words, the destruction of the cutting edge of the drill is a progressive one, whose fundamental cause is that the face of the flute of the drill is too hard.

The drills that were considered soft worked successfully, because even though they could be touched with a file, they were still hard enough so that the metal of the cutting edge would not flow under the strain of the cut. This I would consider an ideal condition for a tool of this class, even though the material to be drilled is very hard. My experience has been that the margin between "too hard" and "too soft" is very small on drilling tools.

It seems that the conditions under which a drill works are such that the tendency of the cutting edge of a drill that is a little too hard on its extreme corners is to crumble off, with the results noted above. This would seem to me to account for the failure of the hard drills you referred to, athough I have always supposed that the conditions I have outlined above were well known to drill manufacturers.

Plainfield, N. J. F. S. THOMPSON.

Your editorial entitled "Why Does a Drill Cut?" is interesting but if this was changed a trifle so that it would read "Why Does a Drill Not Cut?" I believe you would receive more correct answers, so there is liable to be much more complaint from that side than the other.

It would be interesting to the writer to know the different kinds of high-speed steels which will cut better a trifle soft than harder, for the reason that in the factory, where the writer is superintendent, experience has shown exactly the opposite result. We have tried Novo, White-Label and Blue-Chip drills under equal conditions and on automatic machines, the result of all three being that the harder the drill up to the danger point of breaking, the longer the life.

In a recent issue of your paper, there is a long article describing the carbonizing, harveyizing and case-hardening of low-carbon steels. This sort of a thing the writer is particularly familiar with and consequently appreciated the article very much. There was, however, a very valuable point in this connection omitted and that is the localizing of the carbonizing effect, so that a particular spot or section of an article can be made glass hard without affecting the rest of the steel. This is accomplished by either copper, nickel or brass plating the article all over and then removing the plating on the portion where the hardness is desired, then proceed as if you were to carbonize and harden the whole piece. The result will be glass hardness where the plating has been removed and the balance of the article not affected at all.

Some manufacturers use a more convenient method than scouring off the plating and that is to apply ordinary bicycle enamel to the place where the hardness is required, baking it on, then in the plating bath this portion is protected from the deposit. When the work is heated in the carbonizing material, the enamel readily burns off and leaves the surface clear for the carbon to enter.

Springfield, Mass. E. E. NEAL.

Should Results or Time be Paid For?

Mr. Osborne, in his article on whether one should pay for results or time, involves the principle that manifests itself in a thousand different forms and that confronts every shop superintendent in one phase or another. It appears that the individual character of each case will determine who stands the brunt of the charge, for surrounding conditions make each case have its own decisive features.

In the particular case cited by Mr. Osborne, I believe that the shop doing the work has a little the stronger claim and that it should be paid for all the time spent by both men. The shortsightedness of the sawmill man is directly the cause of the trouble. In his letter there was an urgent call for help—send a man quickly, and yet, in spite of the urgency of the occasion the information that would have facilitated most toward getting his engine going was left out. It would have been little or no trouble for him to have given the size and the kind of engine in his letter, and other such ordinary information that any thinking person would have put in an urgent call for help. I do not think that a shop should stand the expense that is directly caused by the almost inconceivable ignorance of a man running a mill that uses various kinds of engines and various pieces of machinery.

But well do I know this ignorance exists and that these people in the backwoods think that a mechanic has magic power and that as he comes in sight all machinery, regardless of tools or facility should immediately jump into operation. A similar case came up in connection with a cotton-press job. Some few years ago a company in the South started installing round-bale cotton presses; there were heavy, hydraulic-operated machines with many heavy parts—cross braces, levers, etc. These were installed in the country places at the cotton gins and were intended to take the places of the square bale which is pressed at the gin and then re-pressed at the coast for export. A month after the installation of such a press and the operation of it, came a telegram from the near-by station reading. "Underneath casting 3 feet long, 1 inch thick, broken, send one by express." Now, that was indeed enlightening for there were various links and levers and cross braces, some cast iron, some malleable, that answered this explicit (?) description. The company was powerless and sent word back: "Wire pattern number of broken casting" thinking, of course, that this would be done and the matter fixed up, but the answer came. "Number 66792—we are broken down, business suffering." Now the manager whistled and said he had not pattern 66792, his patterns did not run over 1000. After a little I

looked in the record book and 66792 was the license serial number on the name plate of the whole machine.

To say we were disgusted does not express it, for already a day of more had been lost and since the new press was just being introduced, we were most anxious for its continued operation and success. So off I was packed that night, seventy miles, on the first train, for we thought further letter, etc., would be of no avail. On landing next morning after a five-mile drive, I found the owner of the gin sitting up smoking a pipe on the porch of the country store. "Well," he said in his southern drawl, "I'm powerful glad to see you, we ain't done a turn in two days and look at this cotton piling up here awaitin.'" Off we struck a few hundred yards to the gin house and there to my disgust was a cross support broken. Nothing but a dummy would have shut down for it, but down she had been for three days for a casting whose use was about the same as a platform and railing around a big engine unit. Also there in letters ½ inch high was "R342" the pattern number. "Start her up," I said, and the talk on pattern numbers won't do for print. Needless to say the gin man paid for my expense in addition to the new casting.

And so I say "No!" the shop man should not pay for the short sightedness, the ignorance of some backwoodsman who could, with three words, have eliminated unnecessary expense.

Butler, Penn. WILLIAM LONGSTREET.

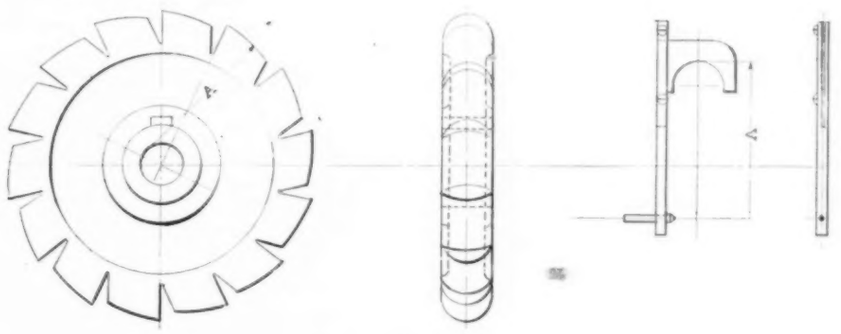
On page 341 is an article entitled, "Should Results or Time be Paid For?" I should say that both results and time should be paid for. In the first place they knew they had several makes of engines and it would have been very easy for their engineer to report to his superintendent which engine was out of order. It certainly showed poor executive ability on their part in giving such meager details. While it is very evident that the first machinist did not fix it, he tried to the best of his ability and then he showed good judgment when he copied the name of engine and reported it to his own superintendent. Many a machinist would have been so rattled he would have gone right back next day and reported he had never seen an engine like it and could not fix it. As machinist No. 2 fixed it all right I think a diplomatic letter written to the lumber company showing them their mistake in not sending details, and charging them bare expenses for machinist No. 1 besides regular bill for machinist No. 2 would not be amiss. While they would probably feel hot for a short time they could not help but see the justice of it.

Newburgh, N. Y. GEO. H. HANDLEY.

A Backing-off Gage

Our tool-room equipment does not afford every available convenience so when it came to backing off a formed milling cutter with a file, we were in trouble.

The mill was 8 inches in diameter with a rounded face ⅝ inch radius. The exactness of the radius did not matter as much as did the clearance angle in each tooth, so that, in re-sharpening, each tooth would perform its share of cutting. It was this filing a uniform clearance on each tooth that caused me to construct the simple gage shown, for gaging the clearance in each tooth as it was being filed.



A BACKING-OFF GAGE

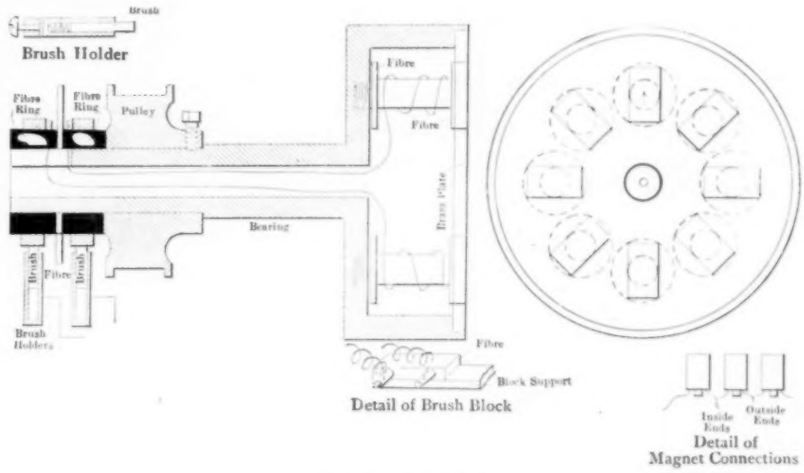
The way I used it was first to plug the hole and then carefully locate the center, from which I described a radius the length of which, as will be seen, determined the clearance angle.

Then drawing a line through the center at right angles to the radial face of the tooth to be backed off, the intersection of the circle and this line located the center for the pin *a* in the gage. Reference to the illustration will now render the scheme clear. The job met every requirement for which it was intended.

Cleveland, Ohio. S. PETERS.

A Cheap Magnet Chuck

It was necessary to grind a large number of rings varying from 3½ to 4½ inches in diameter; in order to avoid the loss of time required for chucking in the ordinary way, the magnetic chuck shown in the cut was designed. A good grinding machine was available, so this special tool was made to take the place of the live spindle; as it was necessary to change quickly either from regular grinding to this special work or back again, an entire new head was made so that the changes would take but very little time.



A MAGNETIC CHUCK

The main part of the magnetic chuck is a gray-iron casting having a hollow shank through which the wires are passed. This casting was machined all over, and at the rear end of the hollow shaft a slot was milled through which the connecting wires were brought out to collector rings. These collector rings were of copper insulated by fiber washers, as shown. It was not deemed necessary to key or fasten these washers in position, as fiber has a tendency to shrink and if made with a reasonably tight fit at first there is practically no danger of their ever moving. The brushes were of the common copper-gauze type made by cutting a strip of gauze of the desired width on a bias, rolling it tightly and soldering the seams. The brush holders were made of ⅜-inch brass rods drilled with a 17/64-inch hole, or just large enough to allow the brush to slide easily with a little shake. These holders were mounted in a block of fiber in drilled holes and were provided with a small screw for binding the wires. The

wires used were stranded in order to get a maximum of flexibility.

The magnets were made of ordinary soft steel with a ⅝-inch core; eight of them were used in order to distribute the pull uniformly over the face of the chuck. The ends were slabbed as shown in order to reduce magnetic leakage. They were also insulated by means of fiber washers. The magnets were wound with No. 25 wire and the connections were made as shown in order that alternate poles would be N and S respectively. A ¼-inch brass plate was fitted over the ends with its outer face flush with the ends of the magnets' cores. After having been ground true, this surface was the one against which the parts to be ground were held.

Syracuse, N. Y. E. J. WILLIAMS.

Making Master Cams

In Mr. Lowe's recent article on cams, page 308, I notice that he uses cosines to calculate his dimensions. This necessitates starting at the highest point of the cam and working backward, or down.

Not long ago I had occasion to lay out a few cams very similar to Mr. Lowe's and in place of using cosines I used the versed sine. By this method I was able to start from the lowest point, referring to Mr. Lowe's sketch point 18, and work upward. This method gives the distance from the starting point of the roller to the point under consideration.

For illustration: Assuming that point 18 is $\frac{13}{64}$, or 0.2031 inch as in sketch, the distance from point 18 to 17 will be the versine of 10 degrees and this will give, versine 10 degrees = 0.01519, 0.01519 × 0.2031 = 0.00308. From 18 to 16, versine 20 degrees = 0.06031, 0.06031 × 0.2031 = 0.01225. From 18 to 15 versine 30 degrees = 0.13397, 0.13397 × 0.2031 = 0.02721.

A table of differences is made in the same way that Mr. Lowe obtains his, for the milling-machine operator in making his master cam. JOHN COAPMAN.

Rochester, N. Y.

Using the Universal Drafting Machine on a Vertical Drawing Board

The custom is growing among engineers, designers and draftsmen of working on a vertical drawing board, and it is used almost exclusively in France, Germany and Switzerland.

The application of the universal drafting machine to the vertical drawing board seems to be difficult and cumbersome, because the weight of the moving parts has to be balanced in the horizontal as well as in the vertical direction, so that the machine will remain immovable at any point of the board.

I have seen two drafting rooms equipped with machines on vertical boards; but their methods of suspending the machine were defective and inconvenient.

Figs. 1 and 2 show a system of suspending and balancing the machine so that the wooden handle with the scales will remain stationary at any point upon the board.

A small, loose pulley is attached at *C* to the rod 16½ inches from the left-hand pivot on machine No. 1; a cord fixed in *A* runs over the pulleys *B*, *C*, *D* and *E*; at the end is the counterweight *F*, 1½ to 2 pounds. The traveling pulleys *G* run along the iron bar *H*.

The dotted lines show the pulley *C* and the counterweight *F* fixed through the hook *K*, so that the board can be set horizontally for tracing without any difficulty.

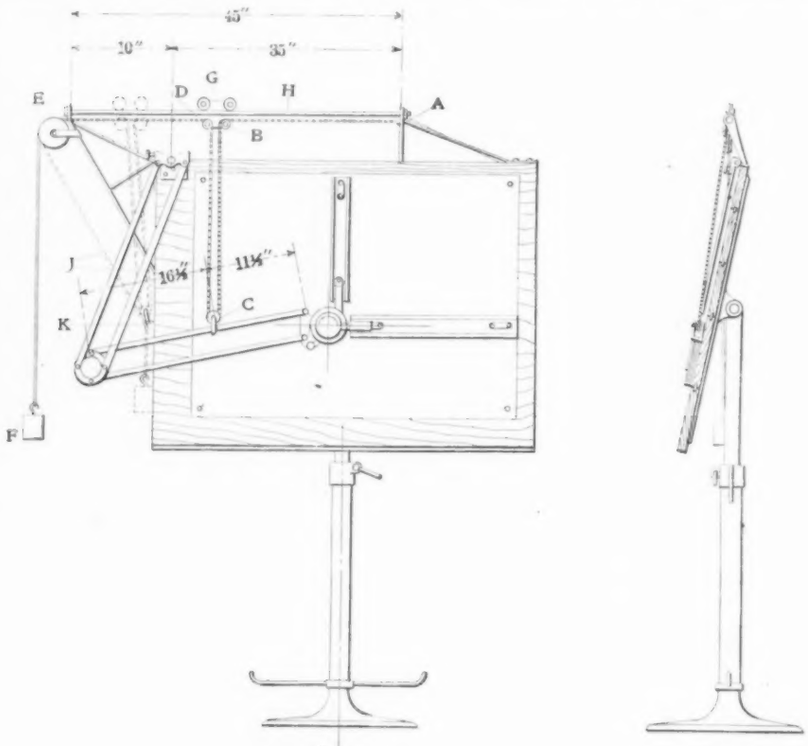


FIG. 1

FIG. 2

USING UNIVERSAL DRAFTING MACHINE ON A VERTICAL BOARD

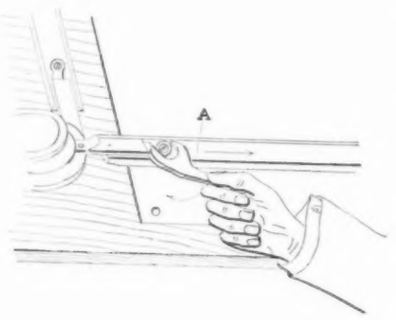


FIG. 3. REMOVING SCALES FROM MACHINE

Fig. 3 shows a simple method of taking out the scales from their chucks with the standard key of the drafting machine; but bend it a little at *A* so that it may be better grasped with the hand.

Winsted, Conn. JOHN A. CHAPPINS.

Hardening a Drop-hammer Die made of Poor Steel

I had a drop-hammer die given to me to harden and was told that it was a piece of a well known brand of high-grade steel which it later proved not to be. The dimensions of the die were 9 inches long, 4 inches on the base and 3¾ inches on the face and it was to be used for stamping name-plates out of thin, soft sheet steel. As this die had to be perfectly straight, I was very careful in hardening it and I generally have very good luck in keeping dies straight on the face. As this die could be ground but very little and lapping out the impression was entirely out of the question, I was doubly careful and was successful in keeping it straight, but found upon testing it with a file that the corners only were hard. Not being able to understand the reason why it was soft, I immediately looked up the man that made the die and asked him how much he had planed off the face of it, thinking it had become somewhat decarbonized on the surface in being forged; but when he assured me that he had taken no less than one-eighth of an inch off the face I came to the conclusion that either I or the steel was at fault, so I heated it up again and hardened it in the same manner as before only I put a little cyanide of potassium on the face; still it came soft again but with

a slight bulge both in the face and the shank.

It might be well here to explain my method of hardening dies. In heating any dies I put them in the furnace face up, as I have found that the parts that lie on the brick floor have a tendency to decarbonize; this applies to any piece that is being hardened and when a hard surface is required all over the article should be turned occasionally.

Having my die at the desired heat I grasped it in the center, face up, and dipped the shank the same as if I were water annealing a piece of steel, only taking care that no water touched the face as that would cause soft spots. Then having cooled the shank so that it will not harden I plunge the die in the water face up and force a stream of water on it with a hose until it is cool enough so that you can almost keep your hand on it while it is still under water, then remove and put it quickly as possible into a tank of oil until it is quite cold or at about the temperature of the air.

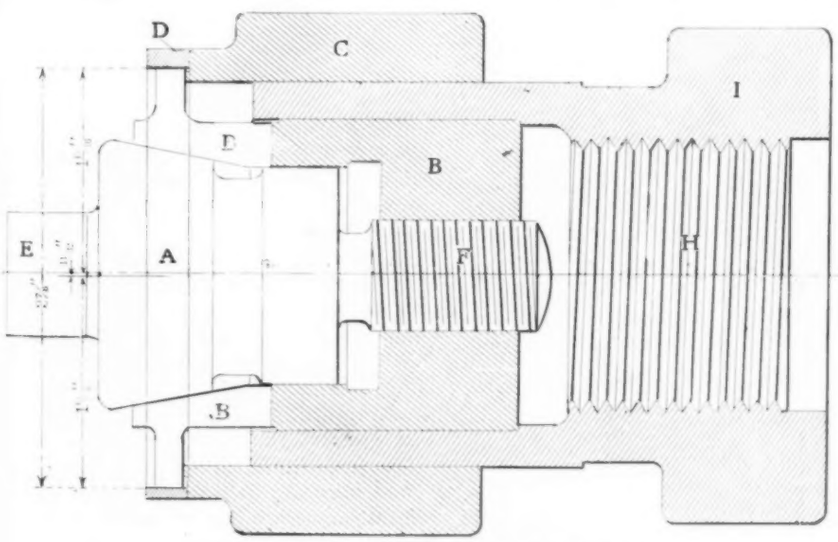
To return to the die in question, I was sure when it was soft the second time that there was something wrong with the steel, so I took it to the foreman of the forge and asked him what he thought it was made of. He immediately told me that he hadn't a piece of that supposed brand of steel that size in the shop and it was probably a piece of low-grade tool steel. Not wanting to throw this die away I packed it in bone charcoal, that is bone that has been used once, and packed it in face down in the box, letting the bone come up about half an inch around the side of the die, covering the rest of the die with ashes as I only desired to harden the face. I then sealed it up and put it in the furnace for about eight hours, then took it out and let it cool off in the box. After it got cold I took it out of the box and reheated it and hardened it the same as before and it became so hard that a broken file wouldn't touch it, but owing to being heated so often the shrinking of the steel had caused the face and shank to bulge so badly that the die was useless. I then reheated it and dipped about one inch of the face in the water and held it there with a strong stream of water coming up against the face of it until it was perfectly cold. I found that I had taken a considerable portion of the bulge out of the face so I repeated the operation with the result that the die became as straight as it ever was, the bulge having been transferred to the shank where it was easily ground off and the die is now working as though nothing out of the ordinary had happened to it.

Now this experience not only shows what can be done in a case of this kind, but it also emphasizes the fact that every shop ought to have some kind of a system of marking steel so that when a piece is to be hardened the man who does it will know exactly what he's up against and then the above mentioned trouble would not have to be overcome, as the first operation I put this die through is sufficient to harden it and at the same time to also keep it straight.

Winchendon, Mass. K. CHAMBERS.

Mandrel for Turning Piston Rings

I have noticed in AMERICAN MACHINIST a number of contributions about devices for turning piston rings. The one presented here has been used by a leading automobile factory for some time and has given entire satisfaction. The cut shows quite plainly the working of the device.



EXPANSION MANDREL FOR TURNING PISTON RINGS

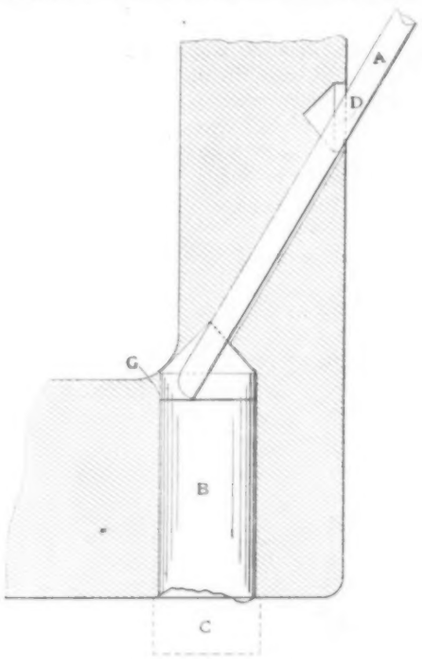
The expander *A* and the expanding ring *B* should both be made of tool steel and hardened. The piston ring *D* is put on the expanding ring and the expander, turned by the square nut at *E*, screws into the expanding ring at *F*, at the same time tightening on the inside of the ring and holding it very securely while it is being turned. This expanding ring *B* is split, as the cut shows, and is turned eccentric at *G* to suit the amount of the eccentricity of the piston ring. The part *C* acts as a stop or bumper for the piston ring, and the part *I* screws on the lathe spindle at *H*.

I have noticed that these piston-ring turning fixtures usually work on this same principle, that is, an expander and split ring which is turned eccentric. There is a wide difference in the way some of them are put together, however, and I am sure the one shown above will be of interest to many.

Flint, Mich. R. B. ALLEN.

Removing Broken Pins

Reading the article at page 177 by W. G. H., on removing the shanks of broken pins in a certain make screw-machine cylinder, recalls to my mind having the same trouble several years ago and using the hydraulic method.



REMOVING BROKEN PINS

I had a few though that would not come that way. The oil would come out in the cored part of the cylinder, and as it was impossible to see the spot where the oil came out, I could not find out whether the casting was porous, or that the hole was drilled into the core as shown by the sketch.

I think the sketch will show how the shanks were taken out. *C* is the part broken off and *B* the shank to be removed. I spotted a small hole as at *D*, then drilled another hole from this, at an angle of 30 degrees so as to have it come out near the bottom of *B*. Then by driving in a piece of small drillrod *A*, loose

in the hole, and rounded on the end to prevent marring the hole at *G*, the pins came out quite readily.

I did not find any of the pieces in very tight, but they always broke just inside the casting and being hard it was impossible to drill them.

The shanks as I remember were just an inch long, so any one that can figure angles could easily tell where to spot the hole *D* so as to make the hole come out near the bottom of the shank. H. C.

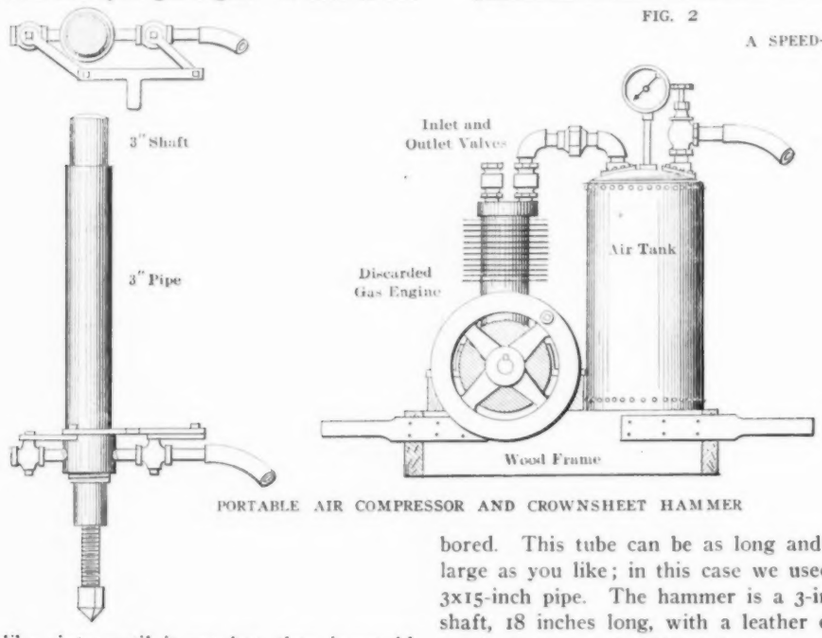
Waterloo, Iowa.

A Portable Air Compressor and Pneumatic Hammer

Inclosed I have sent you a sketch of a hammer which we have used with very good results for work such as it is intended for: driving back crown sheets, holding-on bar and also driving stay bolts in the crown sheets. In fact it can be used in a great many places where it can be used vertically. While it has been used in a small country shop, it could be used to good advantage in an up-to-date shop for driving in close places, as it strikes quite a blow even with the pressure (60 pounds) that we used. We have driven back several good-sized bellies in small fire boxes. We drive them back without heating them, as the fire boxes we have worked on so far are only large enough for a small man and the hammer.

Referring to the line cut, you will see that we have a portable air compressor made from an engine which used to run as a two-cycle gas engine. It used to run somewhat differently from the way it was as an engine when it was used in the shop.

We run a belt around the fly-wheel and drive it from the cone of a drill press. When we take it to the country, we take an extra man along to crank it, as there is a handle provided on the rim of the fly-wheel. The receiver is a 10-gallon galvanized tank which is fastened onto a 2x8-inch frame close to the engine. We take the air through a ¾-inch garden hose from the tank to the hammer. Referring to the sketch of the hammer, the cylinder or tube that the hammer slides in in this case is common pipe bored out smooth. A brass pipe would have been better, as it would not have had to be bored. This tube can be as long and as large as you like; in this case we used a 3x15-inch pipe. The hammer is a 3-inch shaft, 18 inches long, with a leather cup on the bottom end. The tube is screwed into a sleeve which is provided with an inlet and outlet valve, as shown, connected together with a connecting-rod. These valves are common plug valves connected in such a way that when one of them is open the other one is closed.



PORTABLE AIR COMPRESSOR AND CROWNSHEET HAMMER

like sixty until it got hot, then it would back fire and stop. The cylinder is made of 3-inch pipe. One end is screwed into the crank-case; the other end is closed with a pipe cap. The radiating fins are sheet steel, bored and shrunk on tight. As an air compressor it is connected up

A Speed-changing Device

This device has the advantages of a small movement of the speed-changing lever, and requires no adjustment, once it has been fixed, for its operation.

Fig. 1 shows a section through a nest of gears which are proportioned to suit the speeds required. The side frames of the gear box are represented by *A A*, which form bearings for the spindles. The upper set of gears are keyed to their shaft in the ordinary way with a flat feather. The bottom shaft is milled out for a wide keyway, and a sliding key shown in detail in Fig. 2 is bedded down into it. The key and spindle are turned while together to insure a perfect fit for the slide. After this the holes are cut with edges beveled at 45 degrees. The holes for the smaller keys are drilled in the shaft and chipped out square. The keys (see Fig. 4) are then fitted with a spring under each one. The sliding key is then fitted over them all and the gears put in place. As this sliding key is drawn backward and forward, all the keys but one are held down; that one springs up and as soon as the keyway in its gear comes in line, locks it to the shaft. The sliding key is connected to the speed-changing lever. At the end of the lever a quadrant is fixed. The quadrant has a locking pin and holes to fix the lever in the desired position. The dotted lines show the extreme positions of the lever collar and indicate the small amount of travel required.

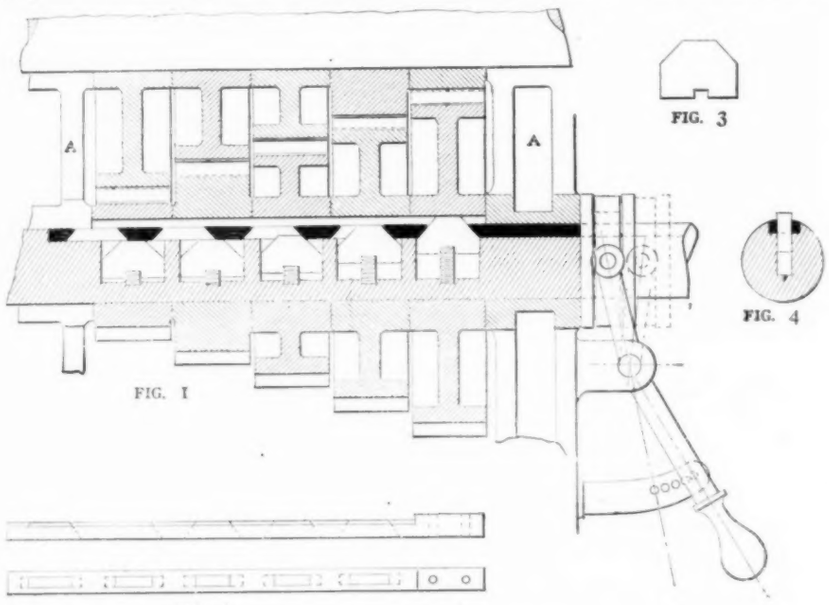


FIG. 1

FIG. 2

FIG. 3

FIG. 4

A SPEED-CHANGING DEVICE

Lincoln, England. E. S. P.

Grinding vs. Cutting by Emery Wheels—Erratum

By a misplaced decimal point an error was made to appear in Mr. Norton's article published on page 451. Instead of *the stock removed per minute per horsepower with the ribbon method was* 0.244 *cubic inch*, appearing in the first column of page 452, read 0.0244 *cubic inch*.

A Diagram for Designing Hoisting Hooks—Errata

In the first line of the chart facing page 170, for *S, the tensile strength of the material in pounds per square inch*, read *S, the maximum allowed tensile strength in pounds per square inch.*

Formula (7), page 171, should read:

$$\frac{B}{b} = \frac{H}{A} + 1 = x + 1. \qquad (7)$$

Cost Accounting—Weights of Round Bar Steel

Your very opportune editorial at page 256 on cost accounting interested me, as at the beginning of 1908 we thoroughly discussed the question as to what percentage of burden should be added to productive labor to cover the manufacturing expense for this year. In 1907 the volume of business was three times that of 1906, and our burden per hour for manufacturing expense was considerably below the average. We finally decided to take the rate for 1906 as that came nearer to the usual average, charging the excess of burden, if necessary, to profit and loss.

Occasionally one wishes to estimate the weight of round bars of steel when the usual tables or pocket books are not within convenient reach. A simple formula easy to remember and accurate within about ⅛ of 1 per cent. is as follows:

Square the diameter of the bar in quarters of an inch and divide the product by 6. The result will give the weight of the bar in pounds per foot of length.

Example. Find the weight of a three-inch round bar one foot long. Three inches = 12 quarter inches, so

$$\frac{12 \times 12}{6} = 24 \text{ pounds.}$$

In the pocket book of the Cambria Steel Company the tables for weights of round steel bars are estimated on a basis of 489.6 pounds per cubic foot. Comparing, we have:

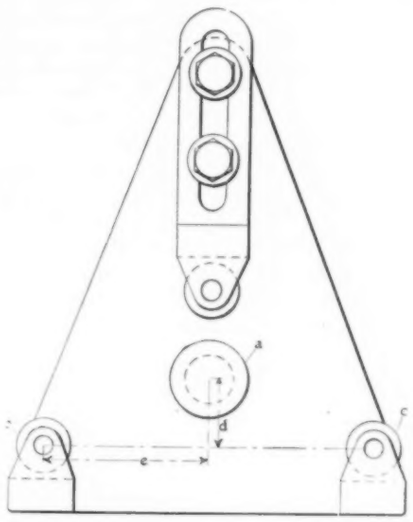
Diameter of Bar in inches.	Cambria, weight pounds per foot.	Weight by Formula, pounds per foot
1	2.67	2.67
2	10.68	10.68
3	24.03	24.00
6	96.14	96.00
8	171.00	170.67
10	267.00	266.67

Hence, the formula is sufficiently accurate for the majority of purposes.

Covington, Virginia. WM. SANGSTER.

Two Criticisms on "Planing to the Arc of a Circle"

The arrangement for this purpose shown by E. A. Dixie at page 216 looks to me as though there would be considerable cramping action when the rolls got near to the end of the guiding arc, unless it was made thinner near the ends than it was in the middle. This could be avoided, however, by making the bracket swivel on the tool slide and providing it with three rolls, as shown in sketch. By



PLANING AN ARC

making the upper roll adjustable vertically, the bracket could then be used with arcs of different radii, as slack could be taken up when the arc or rolls became worn. This bracket could be used with the convex side of the arc either up or down, and has two rolls to resist the pressure of the cut.

This three-roll scheme might at first sight seem to have the disadvantage of not planing a radius the same as that of the guiding arc, as the radius described by the point of the cutting tool will always be equal to the distance of the center of the swivel pin *a* from the center of curvature of the guiding arc. But the radius of the guide is easily computed from known data, as follows:

R = required radius of work.
r = radius of rolls.
d = distance of a above b and c.
e = half distance of b from c.

Then for planing a concave arc, as shown by Mr. Dixie, the outer radius of the guide which would come against the rolls b and c would be given the formula

$$\sqrt{(R+d)^2 + e^2} - r,$$

while for planing a convex arc the inner radius of the guide would come against b and c, and this would be given by the formula

$$\sqrt{(R-d)^2 + e^2} + r.$$

The radius of the guiding arc can also be computed by using a table of sines and tangents without involving squares and roots, thus: for planing a concave arc

$$\frac{e}{R+d} = tan.\ x \text{ and } \frac{e}{sin.\ x} - r = \text{radius of guide;}$$

and, for planing a convex arc

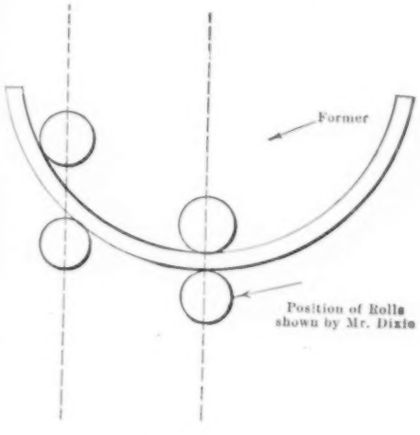
$$\frac{e}{R-d} = tan.\ x \text{ and } \frac{e}{sin\ x} + r = \text{radius of guide.}$$

It is comparatively easy to set the guide and work in their proper relative positions, as the cutting tool is at the extreme end of its vertical travel when the bottom of the swiveling bracket is parallel to the cross rail, providing the bracket is so laid out that the centers of the rolls b and c are equally distant from the bottom of the bracket, and also each is equally distant from the center of a.

Brooklyn, N. Y. WALTER GRIBBEN.

The device on page 216, embodied in the article by E. A. Dixie, "Planing Saddle Pieces to the Arc of a Circle," would not be operative. The sketch herewith will show this to be the case.

The bracket carrying the two rolls with fixed center distance, being attached rigidly to the tool slide, would not admit of any yielding or oscillation of the roll-centers, which would be necessary to render



PLANING ARCS

the arrangement operative. I would suggest that *one* roll, preferably bearing on the upper face of the former, and kept in working contact by a weight or spring, would answer in this case. In using a roll for this purpose, it must be borne in mind that the required radius, plus the radius of the roll used, would give us the radius of the former, if we use a sharp-pointed tool.

Montreal. D. W. GEORGE.

Cutting Screw Threads—The Circular Thread Chaser

Among the recently published letters relating to the various methods of cutting screw threads in the engine lathe, is one at page 986, Vol. 30, Part 2, advising the use of the circular thread chaser, which tool, in my estimation, deserves more consideration than it has been given. My experience with the circular chaser justifies my belief that its use in many cases will result in an equally good product with a great saving of time. My object in writing, however, is not so much to advance the merits of the tool, as to give my views relating to the details of its construction for the consideration of any who contemplate giving it a trial. As Mr. Wilfred advised the use of the circular chaser, with few instructions for its manufacture, the following may prove of interest to some.

Size of Chaser

One of the most important details to be considered in making the circular chaser is its size or diameter. No specific dimension can be given for all, as the size of each will depend upon the size of its work. Therefore, while 2¼ inches may be the right diameter for the chaser in Mr. Wilfred's sketch, the inference given is misleading. As the angle of pitch is different on a thread of different diameters, it is obviously necessary that a chaser with single thread be the same diameter as its work. But any practical use of this principle being impossible on very small work, my method of making the chaser for such is to increase both the diameter and pitch of thread and cut multiple threads on the chaser. That is, taking one which we have in use for example: To cut a single thread 1/16 inch pitch on 13/16 inch diameter of work, my chaser is made twice the diameter and pitch of thread, with double thread on chaser, or 1⅝ inches diameter, ⅛-inch pitch, double thread. Or, as some would prefer it, 1/16-inch pitch, ⅛-inch lead, double thread. The material upon which this chaser works is annealed tool steel, and the results obtained by its use have been very satisfactory.

Unlike the regular die chasers, the circular chaser thread must always be the opposite hand from the thread to be cut.

Tapering Chaser

The top of the thread should be tapered off from the front of the chaser to within a few threads of the back, thus allowing each point to do its proportionate share of the work. The amount of thread removed, as well as the width or number of points on the chaser, must be determined by the conditions governing the use for which each chaser is made. Thus, if it was desired to produce a finished thread at one cut, the first thread on the chaser should be almost entirely removed, but if several cuts are required the first thread on the chaser need only be removed as deep as the chaser is fed into the work at each cut. This tapering should in no way be confounded with cutting a taper thread on the chaser, which would give an entirely different result. The thread on the chaser should be cut straight.

Miscellaneous Hints

In setting the chaser for use in the lathe, care should be taken to set the axis in line with the axis of work. The face plate may be used for a guide if a straight thread is to be cut. The points of the chaser should be set a trifle below center, thus giving clearance which is a feature of this tool. A chaser with square thread, however, does not have this clearance. The work must be the right size before threading, as any attempt at reducing size with this chaser will be sure to give unsatisfactory results. In grinding the chaser the same care must be exercised as when setting it in the lathe, to keep the points parallel and radial with the center. A liberal supply of oil should be used, as, if the supply is scanty, it will all be removed by the first points and the finishing points will cut dry. I do not find the circular thread chaser as simple as Mr. Wilfred appears to regard it, and for ordinary work, in my case, prefer the single-point lathe tool. But for duplicate work made in quantities where the conditions are favorable to its use, I believe too much cannot be said in its favor.

M. A. Young.

Saco, Maine.

Master Plates—Locating and Boring Holes Accurately

Having read the article on master plates by E. M. King, at page 927, Vol. 30, Part 2, and being the possessor of an indicator of the same construction as the one shown in that article, I am prompted to give a description of a job, which, though not strictly "master plate" work may be termed "master piece" work.

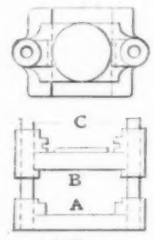


FIG 1

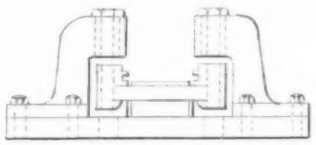


FIG. 2

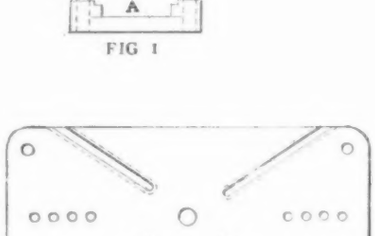


FIG 3

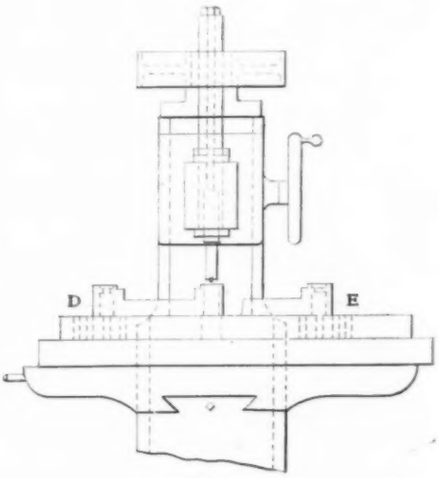


FIG. 4

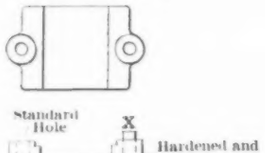


FIG. 5

LOCATING AND BORING HOLES ACCURATELY

While foreman of a tool department, there were a number of punch and die holders to be constructed like Fig. 1, consisting of a stationary and a sliding member made of cast iron, with two pins forced into the stationary member *A*, sliding member *B* being a snug sliding fit on both pins *C*.

The holes in *A* and *B* at first were drilled and reamed in an adjustable jig, constructed somewhat like Fig. 2, the drill as well as the reamer being guided by means of well fitting hardened bushings; the result was altogether unsatisfactory, both as regards accuracy and cost. The pins when forced into the base were seldom perpendicular or parallel with each other, thus necessitating peen-

ing and other doctoring; even then the sliding members fitted more by virtue of elasticity than good workmanship, and were by no means interchangeable.

The superintendent thereupon suggested boring the work in a new vertical-spindle milling machine which tested up very well, and having less work for it than for any other machine, the following method was adopted:

A punch-press bolster, Fig. 3, was at hand, having T-slots and a number of tapped holes, also a two-inch hole in the center, the distance from the center of the two-inch hole to the center of the tapped holes being about equal to the center distance between the pins. This was next bolted to the milling-machine slide as an auxiliary platen. The holes in the bases as well as in the sliding members were rough drilled in a drill press to within 1/16 inch of correct diameter, and then a base was secured to the auxiliary platen with one of the rough drilled holes fitting loosely over a stud *D*, Fig. 4, and the other hole brought under the spindle; this hole was then bored and reamed to standard size. Then the entire lot, both bases and sliding members, were put through in like manner. After this a base was placed upon the platen and the other hole bored to the correct distance from the first hole, then a hardened and ground plug *X* was forced into this hole as in Fig. 5. This base was retained as a model or standard, having thus a standard hole and plug. Another stud *E*, Fig. 4, of standard size was screwed into the platen, the model base was placed with the open hole a good fit on this stud and the plug *X*, Fig. 5, brought under the spindle and the indicator applied in the manner illustrated in Fig. 11 of Mr. King's article. The slides of the miller were next clamped in position, the model base removed and the second hole in each of the bases and sliding members was bored and reamed, the result being perfect fitting parts and interchangeability, not only between the members of the first lot, but also between the members of it and all subsequent lots.

It is better practice to have a stud hole for each hole in the part to be bored, for the reason that if we were to use the same stud hole and place the work end for end, any imperfection in the alinement of the machine would result in a tendency for the pins to slope in opposite directions something like the letter X, when viewed from the end of the work, or a letter *V* when viewed from the side. There is practically no limit to the applications of this method. It may be made to answer very well also for lathe faceplate work, by placing a stud the required distance from the center of the spindle and employing stops against which the work may rest for proper location.

The use of buttons is the more reliable method where extreme accuracy is essential. Especially where the holes in the work are far apart and at quite a hight from the vernier on a miller, any tendency of the slide to sag on either side of the milling machine saddle will give a different result from that indicated by the reading of vernier.

G. H. BERT.

Plainfield, N. J.

Does It Pay to Read?

Of course, when we say "to read" we do not mean "to look at" or "to scan" but to read in an intelligent manner for the proper purpose and in a right spirit.

What is meant by an intelligent manner can better be illustrated by an incident of an unintelligent manner. I once knew a man who would take a paper or magazine, and starting at column one, page one, would read each column and page in order, regardless of whether some article was continued on the next page, column three or not. Of course, such a reader sees only what the dog sees: so many words and pictures. Doubtless, such a manner of reading is unusual, but how many read hurriedly good articles with no other object than to pass the time.

Why does it pay to read the AMERICAN MACHINIST or any other practical journal? Simply because we see there how both brains and skill are solving problems just like our own. Very few mechanics will try to keep to themselves any short cut or new idea they may happen upon. For, they too are always willing to learn and, of course, are willing to help.

Then one can read in a wrong spirit. If we read only to find something to criticize, we will get less than no good from the time employed, and could more profitably be chucking rocks off the pasture lot.

As Mr. Pratt suggests the "writers are in the minority" and in so far as they are in the minority, it pays more to read than to write, for the fact that it pays more people. However, it helps both and sometimes in unexpected ways, as an incident will show:

I was recently discussing a similar idea with a fellow-salesman when he told me this:

"Last week I was in Illinois and went out to see Crawford; you know he is now making a great number of small hardware castings. He said 'Bill I need another kind of small furnace and cannot find just what I want.' We were discussing the subject further and soon he said, 'I saw a neat little furnace described in the AMERICAN MACHINIST a few weeks back that comes near the idea. Wait, I'll show you. You can imagine my surprise when he showed me a write-up of a furnace which I helped to design, and I knew the chap who wrote the article. I was quick to point out the good points of the furnace and as soon as I left, I put my friend next. Since then I have heard that they made the trade."

Wilkinsburg, Penn. A. R. ALLAN.

Hardening Cutting Tools

I have read with interest and pleasure the articles which have lately appeared in the AMERICAN MACHINIST, on the hardening of high-speed and other steels and although I do not profess to be a specialist in this line of work, I have had considerable experience in the hardening of tools and cutters of different shapes and sizes.

When we first started to use high-speed steel I used to read every article on hardening that I could get hold of, and picked out what I considered the best points and worked on these points until I obtained very satisfactory results.

In one shop where I worked, we used nothing but the best grade of high-speed steel we could obtain, for all our cutters and turning tools of which we required a great many different shapes and sizes. We did not possess a lead bath, nor yet a gas furnace. We had only the open fire, and in this fire was done all our hardening. The tools are heated to a good uniform yellow heat and plunged into a bath of raw linseed and lard oil, allowed to stay there until the bubbling and boiling of the oil has ceased, then taken out and put in cold water to cool off.

From this treatment we have had the best and most satisfactory results in machining both cast iron and mild steel. I remember one job in particular. We had to do some large cast-iron cams with a track 5 inches wide and 22 inches deep, tapering toward the bottom. A special conical high-speed cutter was bought for the job. The castings were very hard and before the cutter went half way around the cam we found deep ridges on both sides of the track. We reground the cutter and started up again, with the same results, that is, ridges. We concluded the cutter was not hard enough, so we took it to the open fire and heated it to a very light yellow and plunged it into the bath of raw linseed and lard oil and then cooled it off in cold water. It was then ground up, put on its arbor and started on its work once again.

We were not disappointed with the results, for that cutter milled two cams, which were very hard, and was in good enough condition to do another.

Nottingham, Eng. J. SUTHERLAND.

The button industry, according to the census of 1905, represented a capital of $7,783,900, consisting of 275 establishments, and furnishing employment to 11,335 hands whose aggregate earnings amounted to approximately four and one-half million dollars.

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

The AMERICAN MACHINIST CO., LTD., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1907 *we printed and circulated* 1,151,500 *copies of the* AMERICAN MACHINIST. *Our circulation for March,* 1908, *was (weekly, monthly and European)* 96,750.

April 2..... 36,500
April 9..... 19,500

This paper reaches 36,500 *separate readers each month and* 20,000 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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Industrial Development of India

A great national movement is now on foot which should be of interest to all interested in technical education, and which may eventually prove of great importance to American manufacturers of machinery. Our generation has already witnessed an example of the industrializing of an Asiatic country in the case of Japan. Several years ago that far-seeing nation adopted a policy of sending its young men to be educated abroad, in order that they might build up an economic civilization at home according to the most advanced Western standards. The result we now fully appreciate. China is also, to a greater or less extent, pursuing the same policy. While some of her students go to Europe or America, an especially large number of them are seeking instruction in Japan, thus receiving Occidental knowledge at second hand, but in a manner suited to their own point of view. The commercial outcome is yet to be seen.

And now the third of the great Eastern Asiatic peoples—India—is awakening in a similar manner. Economic conditions there are so low as to be almost inconceivable by us. The political unrest which threatens British domination is due in large measure to the factors that cause poverty. Native raw products, such as cotton, are sent abroad to be worked up and bought back again at a high price. In short, the Hindus are at much the same sort of disadvantage as the American colonists before the Revolution, with the difference that their sufferings therefrom are actual. However much of ancient philosophical learning there may be in Hindustan, the amount of practical education reaching the mass of people is next to nothing, the annual return to them for this purpose out of the money taken from them by the British government being, it is said, a penny and a half a piece. Coupled with the movement for political autonomy, and open to the sympathy even of those who do not approve of that program, is a struggle for industrial independence through the development of home manufactures. To that end, young men must be sent abroad for training.

To coöperate with them in this way, a "Society for the Advancement of India" has been formed in New York. Its plan of immediate operations is one which must appeal to everybody as sensible and worthy. A building called "India House" has been taken at 1142 Park avenue to be used as a means of extending the country's hospitality to the young Hindus that are coming here to study. It is not intended to support them or permanently pay their expenses, but rather to furnish them with a reception as they arrive and a place for coming in contact with the best American life while they remain. A number of them have come there already, and highly intelligent looking youths they are. Apart from all disinterestedness, it is apparent that such an attitude, in contrast to the arrogance with which these Indians are treated by Anglo-Saxons in their own country, must tend to influence them in favor of the United States in their future dealings. The present movement for industrializing this largest and oldest Aryan nation is one that deserves to be watched by those who sagaciously regard the commercial future of America.

The National Society for the Promotion of Industrial Education

The large interest shown at the recent Chicago convention of the above named society has resulted in progress work of sufficient importance to demand a notice at our hands.

The society has leased an office at 546 Fifth avenue, this city, which is now its permanent address. At a recent meeting of the executive committee plans for the reorganization of the former State committees into State branches were matured. It is required that each State branch shall have a membership of at least 50, members of the branches being also members in full standing of the national society—all members of the national society being, in fact, assigned to membership in their respective State branches. The branches are required to hold their annual meetings in September or October of each year, so as to precede the annual meeting of the national society, and other measures have been taken to insure coöperation between the national society and the various branches.

The transactions of the Chicago meeting are to be published in the *Bulletin* of the society and additional *Bulletins* have been authorized, the first of which is to contain a list of institutions for industrial training in the United States. Other *Bulletins* formulate plans for industrial training in various lines of industry, including the boot and shoe, the textile and the building trades. The price of the *Bulletin* has been fixed at 10 cents per copy.

A Forward Move by the American Society of Mechanical Engineers

This society has matured plans for improving the usefulness of its monthly *Proceedings* which now takes the place of the detached copies of the various papers which were formerly sent to the members. In the furtherance of this plan, the society has engaged, as editor of the *Proceedings*, Lester G. French, who is known to many of our readers as formerly the editor of *Machinery*.

Mr. French is a graduate of the Massachusetts Institute of Technology, with several years' practical experience be-

hind him. With these qualifications and his further experience as an editor, we anticipate success in connection with the new movement.

William H. Pfahler

William H. Pfahler, president of the Model Heating Company, died at Pasadena, California, March 29, age 66 years. Mr. Pfahler was prominently identified with the foundry business for many years. He was the father of the employers' organization idea as exemplified by the National Metal Trades Association, which idea has grown to large importance—a growth in which Mr. Pfahler took the keenest interest. It was through his initiative that the National Founders Association was organized and he was also prominently identified with the organization of the National Metal Trades Association, his assistance being recognized by his election to honorary membership in the administrative council of the association.

New Publications

THE OBERMAYER BULLETIN, VOL. 6. 160 5½x8¼-inch pages with numerous illustrations. The S. Obermayer Company, Cincinnati, O. Price 60c.

We are glad to give notice to this bound volume of the bi-monthly bulletin, relating to foundry work and methods which is put out by the S. Obermayer Company. While primarily the publication is a house organ, it contains a large amount of useful information for foundrymen and is offered at a price which is obviously no more than sufficient to cover bare cost.

ENGINEERING REMINISCENCES. Contributed to *Power* and the AMERICAN MACHINIST by Charles T. Porter. 335 6x9-inch pages, with 52 illustrations and 38 full-page portraits. John Wiley & Sons, New York; Chapman & Hall, London. Price, $3, 12s. 6d.

The highly interesting reminiscences of Mr. Porter, which our readers will recall, are here gathered together, although with many revisions and enlargements, while a large number of portraits of Mr. Porter's associates, both living and dead, have been added. The book is of interest, partly as a biography, for it is given to few men to have so varied and interesting an experience as Mr. Porter, partly for its numerous character sketches of prominent men—not all of them creditable, by the way—partly as a history of the origin and progress of the high-speed engine of which Mr. Porter is the unquestioned father, and partly from the many side lights which it throws upon engineering methods and developments during the early days of the high-speed engine, which dates from the early sixties and was first exhibited at the London World's Fair of 1862, where it was the object of great attention.

We have all too few histories of the most striking material development of the nineteenth century, namely, its machinery and its mechanical industries. Mr. Porter saw and was a part of much of this and the keenness of his memory, together with his command of the English language, fit him to write, as he has written, a book of absorbing interest. It should, and we believe will, find a large sale.

STRENGTH OF MATERIALS. By W. C. Popplewell. 180 5¾x8¾-inch pages and 105 numbered illustrations. Oliver & Boyd, Edinburgh, and Hill Publishing Company, New York City. Price $2 net.

A text book prepared from lecture notes, and dealing with the fundamental principles involved in problems of machine and structural design. The subject is divided into two sections; the one deals with the nature and intensity of the forces which act upon a part, the other relates more especially to the effect which these forces have upon the internal structure of the material itself. Following the discussion of stresses, beam flexure, etc., which takes up 12 of the 15 chapters, are three interesting chapters entitled: "Strength of Materials as found from the Results of Tests"; "The Limits of Elasticity"; and "The Materials used in Construction."

Personal*

A. E. Suverkrop, associate editor of this paper, sailed for Europe March 28 on the steamer "St. Louis."

F. J. Smith, president of the S. W. Card Manufacturing Company, sailed April 7 for a two months' business trip abroad.

H. W. Champion, president of the Newton Machine Tool Works, Inc., Philadelphia, sails on the 15th inst. for a business trip to Europe.

James R. Fletcher, chief inspector of the National Cash Register Company, has accepted a position with the Yale & Towne Manufacturing Company as department superintendent.

C. P. Wetmore, until recently superintendent of the Comptograph Company, is at present acting in a similar position with the Stroh Die Moulded Casting Company, Milwaukee, Wis.

Edw. H. Marot, who has been connected with the Philip's Pressed Steel Pulley Works, is now engaged in the engineering department of the Hyatt Roller Bearing Company, Newark, N. J.

William M. Davis, for a long time associated with the lubricating departments of large industrial plants, has established an independent office at 93 Broad street, Boston, Mass, as a lubrication engineer.

H. Gamper, who was connected with the engineering staff of the Sherwin-Williams Company, has recently entered the municipal service of the city of Columbus, Ohio, as superintendent of lighting department.

John C. Spiers has been appointed factory manager of the Standard Roller Bearing Company, in full charge of the manufacturing department. Mr. Spiers held a similar position with the Auto-car Company.

Chas. C. Tyler, formerly superintendent of the Pratt & Whitney Company, and later works manager of the National Cash Register Company, is at present holding a similar position with the Remington Arms Company, Ilion, N. Y.

Fred K. Potter, for many years connected with the Capell Fan Engineering Company, has been appointed manager of the Sirocco Engineering Company in the Pittsburg district, with offices in the Keenan building, Pittsburg, Penn.

Chas. A. Alexander, until recently mechanical engineer with the German-American Button Company, has established a business of his own at 17 Madison street, Rochester, N. Y., as reinforced concrete construction engineer and contractor.

O. S. Bickford, foreman and designer of special machinery for the past 11 years with the Wells Brothers Company, has left the employ of this company to open a jobbing machine shop, with special attention to the design and building of special machinery and tools.

Harry P. Townsend has joined the forces of the E. J. Manvile Machine Company, Waterbury, Conn., and will act in the capacity of designer and consulting engineer. Mr. Townsend was formerly employed by the Corbin Cabinet Lock Company as mechanical superintendent.

Henry O. Evans, formerly connected with the firm of J. E. Lonergan & Co., and more recently engaged in the manufacture of automatic tapping machinery, under his own patents, has associated himself with the Detroit Brass Works, Detroit, Mich., as mechanical engineer. Mr. Evans' principal work is the installing and building of the tapping machines.

Anton M. Olsen, apprentice with the firm of the Kempsmith Manufacturing Company, Milwaukee, Wis., was the recipient of a diploma under the uniform apprenticeship contract adopted by the Machine Tool Builders' Association. Mr. Olsen is the first Western apprentice to capture a diploma, and the presentation was made the occasion for an evening luncheon, at which were present all the apprentices, foremen, superintendent and executive officers of the Kempsmith Manufacturing Company.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

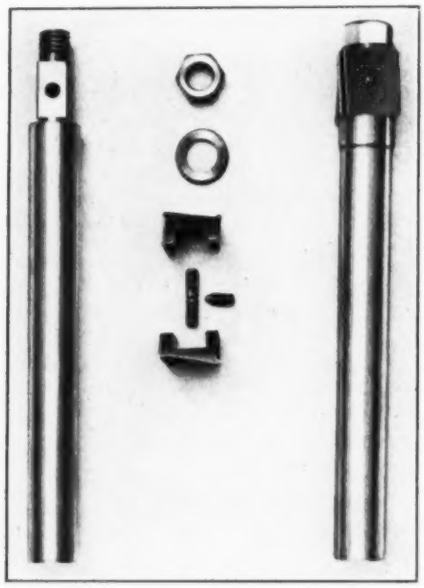
The Turney Adjustable High-speed Reamer

The reamer shown in the accompanying half-tone is the Turney adjustable high-speed reamer. It has but recently been put on the market but has been used in a large machine-tool plant for about two years, in which case it did away with the hand reaming which was formerly necessary to produce smooth holes and preserve standard sizes.

The reamer heads are made of high-speed steel and have a square cross section with four lips on lands cut solid on the head with a left-hand spiral (5-degree angle).

The heads are made in two parts, each section having a channel on the underside. They are ground, after hardening, to fit over the squared end of the reamer shank. This preserves the alinement and prevents the possibility of the reamers turning the shank.

Parallel adjustment is obtained by means of a double end right- and left-hand screw which is held in the reamer shank at right angle to the axis and engages in threaded holes in the reamer head.



AN ADJUSTABLE REAMER

The reamer heads are locked firmly against the shoulder of the shank in the rear of the squared portion by means of a nut and washer at the front end of the shank.

The reamer is simple and strong; there are no blades which refuse to be pushed along in slots to obtain expansion; it expands parallel throughout its entire length and it is only necessary to grind away a small amount of metal when a resetting and grinding are desired.

Over 100 holes 3¼ inches diameter and 6 inches long have been reamed in bronze with this reamer without any appreciable wear and it has done excellent work in cast iron, steel, copper and babbitt as well.

It is being marketed by The Grant Nail and Supply Company, 47 High street, Boston, Mass.

A Peculiar Drill Combination

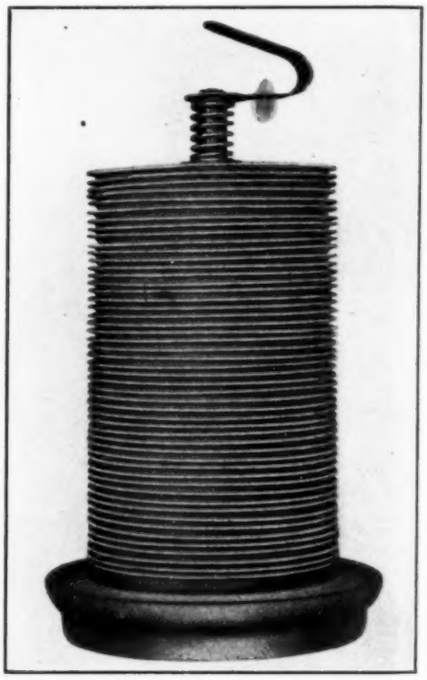
By an oversight we neglected to state that the maker of the gang of drill presses shown on page 552 is the Cincinnati Machine Tool Company, of Cincinnati, Ohio.

A Novel Type of Electrolytic Lightning Arrester

Although lightning arresters are not usually considered part of a machine-shop equipment, it is comforting to know that a thunder storm will not put the power plant out of business and shut down the shop.

As the result of experiments covering a number of years, the Westinghouse Electric and Manufacturing Company, Pittsburg, Penn., has developed the electrolytic lightning arrester shown herewith. It consists of a number of aluminum plates pressed into tray form so that when set one within the other, separated by small insulating washers, they may be built into a column capable of withstanding high voltages and still retain the safety-valve characteristics of a single plate. These columns are made in two sizes, one for voltages between 4000 and 7500, the other for voltages between 7500 and 15,000. The columns are inclosed in substantial stoneware jars. The jars may be mounted one upon the other to form arresters for any desired voltage. A gap on the line side of the electrolytic elements, which will withstand the normal voltage of the system, breaks down with over-voltage and permits the surge to discharge through the electrolytic units.

The electrolytic solution causes a very thin film to form on the aluminum plates. This film has an apparent resistance of very high value when moderate voltages are impressed upon it, but when the voltage reaches a certain value, it breaks down in myriads of minute punctures, making almost a short circuit. As soon, however, as the voltage is reduced again, the punctures seal up at once and the original high resistance reasserts itself. These arresters are arranged for installation either indoors or out, as suits the convenience of the user.



ELECTROLYTIC LIGHTNING ARRESTER

Recent statistics quoted by Consul Francis B. Keene, of Geneva, show that, out of a total population of about 3,500,000 inhabitants, the total of persons employed in the watchmaking industry in Switzerland is 115,617, of which 55,988 are male and 59,629 female. The total of watchmakers is 52,752, of which 35,378 are men and 17,374 women.

It is reported from Paris that all submarine boats are soon to be equipped with detachable telephone buoys. With this device aboard should an accident be met with and the boat sink to the bottom the buoy can be sent to the surface and thus attract attention. Communication can then be established and means taken to accomplish rescue.

Government Tests of Alcohol versus Gasolene

The Technologic Branch of the United States Geological Survey under the direction of J. A. Holmes, has recently completed an elaborate series of tests on the relative value of gasolene and alcohol as producers of power. The tests, over 2000 in number, probably represent the most complete and exact investigation of the kind that has been made either in this country or abroad, and include much original research work.

Prof. R. H. Fernald, engineer-in-charge of the gas-producer section and professor of mechanical engineering in the Case School of Applied Science, Cleveland, Ohio, was in general charge of the tests. R. M. Strong, formerly connected with the engineering department of Columbia University, had personal supervision of the work. He was assisted by a corps of specially trained men.

These tests were conducted at the fuel-testing plant of the Geological Survey at Norfolk, Va., and show the following results in regard to the comparative fuel consumption of 73-degree specific gravity gasolene and commercial completely denatured alcohol, per unit of power.

Correspondingly well designed alcohol and gasolene engines, when running under the most advantageous conditions for each, will consume equal volumes of the fuel for which they are designed. This statement is based on the results of many tests made under the most favorable practical conditions that could be obtained for the size and type of engines and fuel used. An average of the minimum fuel-consumption values thus obtained, gives a like figure of eight-tenths (0.8) of a pint per hour per brake horse-power for gasolene and alcohol.

Considering that the heat value of a gallon of the denatured alcohol is only a little over six-tenths (0.6) of that of a gallon of the gasolene, this result of equal fuel consumption by volume for gasolene and alcohol engines probably represents the best comparative value that can be obtained for alcohol at the present time, as is also indicated by continental practice. Though the possibility of obtaining this condition in practice here has been thoroughly demonstrated at the Government fuel-testing plant, it yet remains with the engine manufacturers to make the "equal fuel consumption by volume" a commercial basis of comparison.

The gasolene engines that were used in these tests are representative of the standard American stationary engine types, rating at 10 to 15 horse-power, at speeds of from 250 to 300 revolutions per minute, while the alcohol engines were of similar construction and identical in size with the gasolene engines.

The air was not preheated for the above tests on alcohol and gasolene, and the engines were equipped with the ordinary types of constant-level suction lift and constant-level pressure-spray carbureters, Many special tests with air preheated to various temperatures up to 250 degrees Fahrenheit, and tests with special carbureters were made, but no beneficial effects traceable to better carburation were found when the engines were handled under the special test conditions, including constant speed and best load.

The commercial completely denatured alcohol referred to is 100 parts ethyl alcohol plus 10 parts methyl alcohol plus one-half of one part benzol, and corresponds very closely to 94 per cent. by volume, or 91 per cent. by weight ethyl alcohol (grain alcohol).

No detrimental effects on the cylinder walls and valves of the engines were found from the use of the above denatured alcohol.

The lowest consumption values were obtained with the highest compression that it was found practical to use; which compression for the denatured alcohol ranged from 150 to 180 pounds per square inch above atmosphere.

Eighty-per cent. alcohol (alcohol and water) for use in engines of the present types would have to sell for at least 15 per cent. less per gallon than the denatured alcohol in order to compete with it. The minimum consumption values in gallons per hour per brake horse-power for 80-per cent. alcohol is approximately 17.5 per cent. greater for the denatured alcohol used than for gasolene. A series of tests made with alcohol of various percentages by volume ranging from 94 per cent. to 50 per cent. showed that the minimum consumption values in gallons per hour per brake horse-power, increased a little more rapidly than the alcohol decreased in percentage of pure alcohol. That is, the thermal efficiency decreased with the decrease in percentage of pure alcohol. This decrease in thermal efficiency or increase in consumption referred to pure alcohol is, however, comparatively slight from 100-per cent. alcohol down to about 80-per cent. alcohol. Within these limits it may be neglected in making the calculations necessary, to compare the minimum consumption values for tests with different percentages of alcohol.

The nearer the alcohol is to pure, the greater the maximum horse-power of the engine. The per cent. reduction in maximum horse-power for 80-per cent. alcohol as compared with that for denatured alcohol used was less than 1 per cent., but the starting and regulating difficulties are appreciably increased.

With suitable compression, mixtures of gasolene and alcohol vapors (double carbureters) gave thermal efficiencies ranging between a maximum of 22.2 per cent. for gasolene and a maximum of 34.6 per cent. for alcohol, but in no case were they higher than that for alcohol. The above thermal efficiencies are calculated from the brake horse-power and the low calorific value of the fuel, which for the gasolene was 19,100 British thermal units per pound was 10,500 for the denatured alcohol.

As has been previously published, alcohol can be used with more or less satisfaction in stationary and marine gasolene engines, and these gasolene engines will use from one and one-half to twice as much alcohol as gasolene when operating under the same conditions. The possibilities, however, of altering the ordinary gasolene engine as required to obtain the best economies with alcohol are very limited; for the amount that the compression can be raised without entirely redesigning the cylinder-head and valve arrangement is ordinarily not sufficient, nor are the gasolene engines usually built heavy enough to stand the maximum explosive pressures, which often reach 600 and 700 pounds per square inch. With the increase in weight for the same sized engine designed to use alcohol instead of gasolene, comes an increase in maximum horse-power of a little over 35 per cent., so that its weight per horse-power need not be greater than that of the gasolene engine and probably will be less.

The work was taken up to investigate the characteristic action of fuels used in internal-combustion engines with a detailed study of the action of each fuel (gasolene and alcohol) as governed by the many variable conditions of engine manipulation, design and equipment. These variables were isolated, so far as possible.

A large number of fundamental tests were necessary in order to clearly define conditions and interpret results. In a way they follow the work conducted by the Department of Agriculture, supplementing to a certain extent, but not duplicating, *Bulletin* 191, which gives many data of general value.

Many of the tests of the internal-combustion engines have been made, but most of them, especially in this country, were by private concerns, for a specific purpose, and the results are not generally available. Furthermore, as is generally recognized by those familiar with gas and especially gasolene-engine operation, the conditions influencing engine performance are so numerous and various, as to make the value of off-hand comparison very limited and oftentimes misleading, exact comparisons only being possible under identical conditions, or with reference to the actual known differences in all conditions that influence the results.

With a view to supplying the continually increasing demand for more complete and exact information concerning the operation and design of gasolene and alcohol engines, and to assist the Government and others interested in the larger and more general internal-combustion engine problems, this investigation was made.

Business Items

The Lunkenheimer Company, Cincinnati, Ohio, has opened a store in Chicago at Lake and Dearborn streets.

The S. Obermayer Company has opened a warehouse at 1604 North Broadway, St. Louis with C. M. Barker in charge.

The contract for the electric turret-turning gear of the United States steamship "Delaware," now under construction at Newport News, has been awarded to the Cutler-Hammer Manufacturing Company, of Milwaukee.

The Atlantic Tool and Machine Company, Atlantic building, Chicago, has made a contract with the Garner Tempered Air Ventilator Company for building its machines, and for designing various sizes and various types according to their special purposes.

The New England Steel Casting Company, of Hyde Park, Mass., has leased the plant of the Worcester Steel Foundry Company, of Millbury, Mass., and will operate it as the Worcester Steel Casting Company. The Worcester Steel Casting Company will be under the same management as the New England Steel Casting Company, Eugene Edwards, president of the latter company, giving his personal attention to its management. The plant of the Worcester Steel Casting Company, at Millbury, which is a suburb of Worcester, Mass., is thoroughly equipped for the manufacture of crucible steel castings and is especially adapted for making all kinds of intricate steel casting work.

Trade Catalogs

Diamond Clamp and Flask Company, Richmond, Ind. Catalog of automatic and plunger type core machines. Illustrated, 20 pages, 6x9 inches, paper.

S. W. Card Manufacturing Company, Mansfield, Mass. Catalog No. 45, describing taps, dies, screw plates. Illustrated, 122 pages, 4½x7 inches, paper.

H. W. Johns-Manville Company, 100 William street, New York. Catalog No. 107, describing asbestos wood. Illustrated, 20 pages, 3½x6 inches, paper.

The Whitman & Barnes Manufacturing Company, Chicago, Ill. Catalog No. 67, describing Economy high-speed flat drills and chucks and Norka high-speed twist drills and chucks. Illustrated, 16 pages, 6x9 inches, paper.

The Tabor Manufacturing Company, Eighteenth and Hamilton streets, Philadelphia, Penn. Treatise on the Taylor universal tool grinder, including detailed instructions for forging and grinding Taylor standard shape cutting tools, with suggestions for tool room arrangement and description of the Taylor belt bench. Illustrated. 112 pages, 6x9 inches, paper.

Manufacturers

T. M. Nash, Macon, Ga., will build a blacksmith shop.

Roberts Brothers, Baltimore, Md., will establish a cannery at Americus, Ga.

Victor Cushwa & Sons, Williamsport, Md., will erect a blacksmith shop.

Harris Gin Company, Troy, Ala., will rebuild cotton gin recently burned.

The American Calking Machine Company, Perry, Iowa, is installing machinery for the manufacture of a calk-turning device and expects to add foundry equipment within a few months.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

Steel case hardened; modern methods. Boston Gear Works, Norfolk Downs, Mass.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Model making. Patented machines manufactured on royalty. Rotary File & Machine Co., 589 Kent Ave., Brooklyn, N. Y.

Wanted—Second-hand Rivett back geared 8-inch precision lathe and attachments in good condition. C. Nutter, Topeka, Kan.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Inventions, novelties, ideas, etc., developed; special machines designed. Albert Pott, M. E., 23 Platt St., New York, and Waterbury, Ct.

If you have a copy of March 7, 1907 AMERICAN MACHINIST we'll give you fifteen cents for it. AMERICAN MACHINIST, 505 Pearl St., New York.

Automatic machinery designed; special purpose machines; working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Wanted—At once second-hand No. 2 B. & S. universal milling machine; state very best price and delivery. Address F. Mfg. Co., Care of AMERICAN MACHINIST.

Gears cut to order, bevel, spur and miter, on Bilgram and Gleason machines. Complete gears furnished. The Cincinnati Gear Works, Murdock Building, Cincinnati, Ohio.

Special machinery designed, new ideas developed to practical results; tell me the conditions you wish to improve and I will do the rest. Box 950, AMERICAN MACHINIST.

We want a copy of Nov. 22, 1900 issue AMERICAN MACHINIST. Address AMERICAN MACHINIST, 505 Pearl St., New York City.

Mail your invention for free opinion and how to patent and profit without expense to you. E. P. Thompson, M. E., member A. S. M. E., A. I. E. E., etc., 53 West Morningside Ave., New York City.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

MASSACHUSETTS

General foreman who knows nothing except to produce results, desires change. Box 16, AMERICAN MACHINIST.

First-class metal patternmaker, experienced on hand and molding-machine patterns, wishes position. Will go anywhere. Box 938, AMERICAN MACHINIST.

NEW JERSEY

Mechanical expert wishes to perfect your automatic machine or take charge of drafting room. Box 19, AMERICAN MACHINIST.

NEW YORK

Mechanical draftsman wants a position. Box 12, AMERICAN MACHINIST.

Position by all-around machinist, well up in electrical machine repairs and maintenence. Address Box 22, AMER. MACHINIST.

Position as superintendent, manager or assistant; have had 10 years' experience in selling and manufacturing; best of references. Box 14, AMERICAN MACHINIST.

Screw machine foreman, active, energetic, age 35, with up-to-date methods for producing work at minimum cost; wide experience on Jones & Lamson machines; bar or chuck work. Box 13, AMERICAN MACHINIST.

Mechanical engineer, college graduate, wants position as assistant superintendent, chief or designing draftsman; experience in steam engineering, air compressors and pneumatic mining machinery; references A-1. Box 21, AMERICAN MACHINIST.

Draftsman, superintendent of factory six years, has designed and patented complete line of machines for his company; taken bridge engineering course I. C. S.; desires to change, preferably with engineer; best references. Box 15, AMERICAN MACHINIST.

OHIO

Foreman toolmaker desires change; a thorough expert on designing sub-press punches and dies, bending, drawing and forming tools, jigs, etc., for very accurate high class repetition manufacturing; excellent references. "L.," AMERICAN MACHINIST.

PENNSYLVANIA

Draftsman, mechanical and structural, college graduate wants position; salary $20 per week. Address Box 23, AMER. MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Wanted—Producer gas engine designer thoroughly up-to-date. Must be wide awake to possibilities and familiar with latest practice here and abroad. Give experience and salary wanted. Box 935, AMER. MACHINIST.

MASSACHUSETTS

Pump Doctors—Expert repair men wanted by manufacturers of trade steam, power, electric driven pumps and small engines. Box 958, AMERICAN MACHINIST.

NEW HAMPSHIRE

Help Wanted—Foreman for brass foundry; give experience and references. Sullivan Machinery Co., Claremont, N. H.

NEW JERSEY

Wanted—First-class designer and originator on hydraulic work, pumping engines, air and steam machinery. Must be fully competent to work out designs, practical experience, ability to redesign, develop and improve requirements. Address with full details, Box 957, AMERICAN MACHINIST.

NEW YORK

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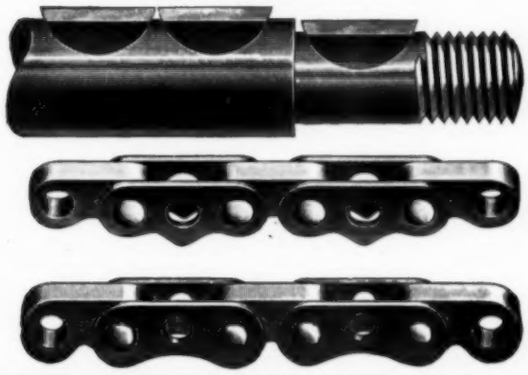

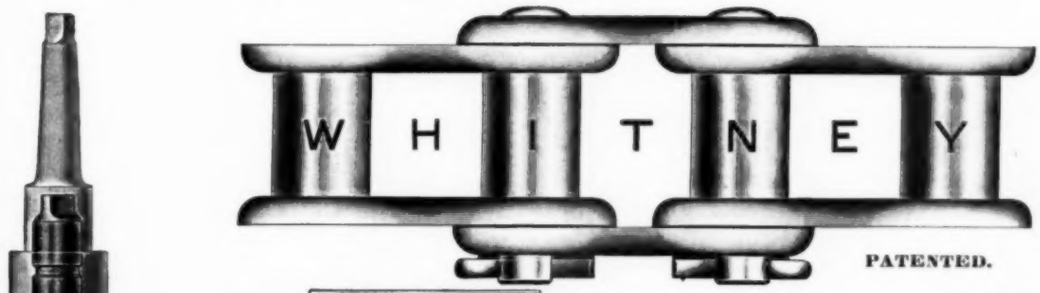

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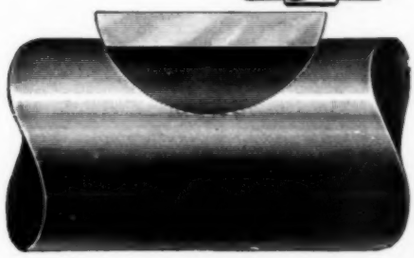


The Whitney Mfg. Co.,

Hartford, Conn., U. S. A.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Conn.

Chisels, Cold

Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co. R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Lancaster Knife and Machine Wks., Lancaster, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Westcott Chuck Co., Oneida, N. Y.
Whitney Mfg. Co., Hartford, Conn.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cincinnati Chuck Co., Cincinnati, O.
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

Harrington & Son Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn
Westcott Chuck Co., Oneida, N. Y.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Westcott Chuck Co., Oneida, N. Y.

Circuit Breakers

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Hammacher, Schlemmer & Co., New York.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Williams & Co., J. H., Brooklyn N. Y.

Clutches, Friction

American Tool & Machine Co,, Boston, Mass.
Bliss Co., E. W., Brooklyn, N. Y.
Caldwell, Son & Co., W. H., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn
Niles-Bement-Pond Co., New York.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Compound, Core

Obermayer Co., S., Cincinnati, O.

Compound, Pipe Joint

Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Machine Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Blaisdell Machinery Co., Bradford, Pa.
Ingersoll-Rand Co., New York.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps

Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Cambridge, Mass.
Cell Drier Mach. Co., Taunton, Mass.
Dietz Machine Works, Phila., Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Manville Bros. Co., Waterbury, Conn
Merritt, Jos., Hartford, Conn.
Turner Mach. Co., Danbury, Conn.

Controllers and Starters, Electric Motor

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic

Lamson Consolidated Store Service Co., Boston, Mass.
Link-Belt Co., Philadelphia, Pa.

Coping Machines

Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum

See Grinding Wheels.

Cotters

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery

Veeder Mfg. Co., Hartford, Ct.

Countershafts

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders Iron Foundry, Providence, R. I.
Coates Clipper Mfg. Co., Worcester, Mass.

Countershafts—*Continued.*

Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, Ohio.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.

Cranes

Brown Hoisting Mach. Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Franklin Port. Crane and Hoist Co., Franklin, Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines

Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts

Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles

Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers

Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas and Ladles, Foundry

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil

Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.

Cutters, Milling

Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hurlburt-Rogers Mach. Co., South Sudbury, Mass.
McCabe, J. J., New York.
Newton Mach. Tool Wks.,Inc., Philadelphia, Pa.
Nutter & Barnes Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Fitchburg Machine Works, Fitchburg, Mass.
Krieger Tool & Mfg. Co., Chicago, Ill.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.

Diamond Tools

American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co Cleveland, O.
Manville Bros Co., Waterbury, Conn

Dies, Sub-Press

Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Allen Co., Chas. G., Barre, Mass.
Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Drawing Boards and Tables

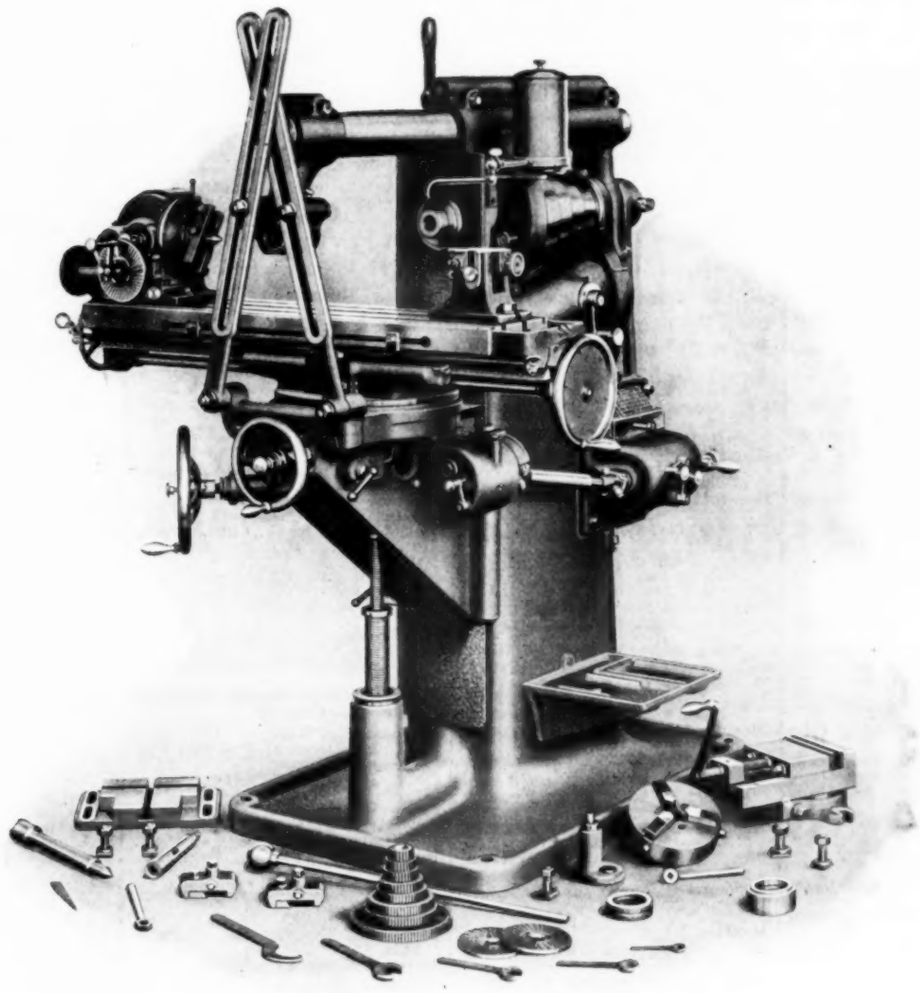
Alteneder & Son, Theo., Philadelphia, Pa.
Kolesch & Co., New York.

Drawing Materials

Alteneder & Son, Theo., Philadelphia, Pa.
Kolesch & Co., New York.
Technical Supply Co., Scranton, Pa.

BROWN & SHARPE MFG. CO.,

PROVIDENCE, R. I., U. S. A.



Quality of the Finished Product is the first consideration in the design of all

B. & S. UNIVERSAL MILLING MACHINES.

While it is important many times to know the capacity of a machine and how rapidly it will turn out work, it is the QUALITY of the work that has to stand inspection.

Circulars, describing any of the B. & S. Milling Machines, will be sent to any address upon application

Drafting Machines

Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench

American Watch Tool Co., Waltham, Mass.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Ingersoll-Rand Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Boiler

American Tool Works Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Multiple Spindle

Allen Co., Chas. G. Barre, Mass.
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Flather Planer Co., Mark, Nashua, N. H.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Conn.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial

American Tool Works Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Turret

Fay Machine Tool Co., Phila., Pa.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright

Allen Co., Chas. G., Barre, Mass.
American Tool Works Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Co., Tool Co. Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center

Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Electric

Chicago Pneumatic Tool Co., Chicago, Ill.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Independent Pneumatic Tool Co., Chicago, Ill.
Van Dorn Elec. Mfg. Co., Cleveland, Ohio.

Drills, Hand

Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic

Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.

Drills, Rail

Foote-Burt Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.

Drills, Ratchet—*Continued.*

Cleveland Twist Drill Co. Cleveland, O.
Hisey-Wolf Mach. Co., Cin., O.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

Drill Speeder

Graham Mfg. Co., Providence, R. I.

Drying Apparatus

American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Eck Dynamo & Motor Co., Belleville, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies

Clark, Jr., Elec. Co, Inc., James, Louisville, Ky.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cincinnati, O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Triumph Electric Co., Cincinnati, O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery

American Tool Works Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.
Western Electric Co., Chicago, Ill.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels

See Grinding Wheels.

Emery Wheel Dressers

American Emery Wheel Co., Providence, R. I.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-Room

Hart & Cooley Co., New Britain, Conn.

Engineering Appliances

Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Engineers, Mechanical and Electrical

Crocker-Wheeler Co., Ampere, N. J.
Merritt, Jos., Hartford, Conn.

Engines, Gas and Gasolene

Automatic Mach. Co., Bridgeport, Conn.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.

Engines, Motor

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

Engines, Steam

American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery

Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads

Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition, Machinery

Philadelphia Bourse, Phila., Pa.

Expanders, Tube

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Export

Churchill & Co., Chas., London, Eng.
C. I. F. Co., New York.

Eyelet Machinery

Manville Bros. Co., Waterbury, Conn.

Factory Equipment

Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equipment & Eng. Co., Boston, Mass.

Fans, Electric

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust

American Blower Co., Detroit, Mich.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., Phila., Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps

Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Heller Bros. Co., Newark, N. J.
Nash Co., Geo., New York.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.
Simonds File Co., Fitchburg, Mass.

Filler, Iron

Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines

Cochrane-Bly Co., Rochester, N. Y.
Henry & Wright Mfg. Co., Hartford, Conn.

Flexible Shafts

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.

Forges

Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Burk Machy. Co., Cleveland, O.
Miner & Peck Mfg. Co., New Haven, Conn.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
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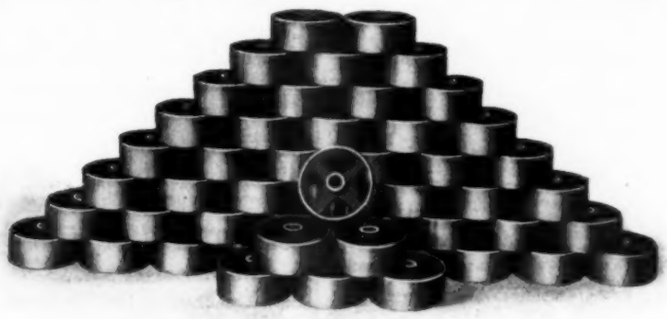

A fair example of what can be accomplished on a Landis Grinding Machine is shown in the above illustration. These cast iron pulleys, 8 inches diameter crown 3½ inches wide were crowned on one of our 12 inch swing grinding machines with average grinding time of 12 minutes each. The metal scale removed was from 1-16 to ⅛ inch thick and this scale was exceptionally hard. We have many pulley crowning examples which are strong proofs of economy.

Ask for information on the crowning of pulleys or write for our new 1908 catalogue.

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